SILVICULTURE SPECIALIST REPORT

Sagehen Project
Tahoe National Forest
Truckee Ranger District
October 9th, 2012

/s/ Scott D Conway

Prepared by ______________________________

Scott D. Conway
Vegetation Management Officer
Truckee Ranger District
10811 Stockrest Springs, Truckee, CA 96161
sconway@fs.fed.us
530-587-3558

/s/ Mark E. Brown

Reviewed by ______________________________

Mark E. Brown
Forest Silviculturist / Vegetation Program Manager
Tahoe National Forest Supervisor's Office
631 Coyote St., Nevada City, CA 95959
markebrown@fs.fed.us
530-478-6239

Contents

Sagehen Project

Silviculture and Vegetation Report

I. AFFECTED ENVIRONMENT

The Sagehen Project Area is comprised of extensive even-aged conifer stands and Jeffrey pine plantations. Elevations range from 6,000 to 7,500 feet, and slopes range from near flat to very steep. Soils are primarily moderately shallow to moderately deep, sandy loams and loams in texture, having relatively high rock fragment content, giving them a low to moderate compaction risk rating.

Stand conditions in the Sagehen Project Area have been significantly altered by human activities since the early 1870s. From the 1870s through 1890s, the Banner Mill, a sawmill, was located within the Basin. During this time, sawtimber was cut and milled within the Basin, after which contractors came in and removed most of the remaining trees in cut areas for cordwood. After the Banner Mill closed, another private timber company, the Sierra Nevada Wood and Lumber Company, began removing sawtimber from the remaining sections in the Basin. A mainline railroad grade was pushed north through the Sagehen Basin. Harvesting by this company extended up in elevation to much of the red fir sawtimber in Section 10, Township 18N, Range 15E. By 1931, the Company had begun to harvest the sawtimber within the Basin with early tractor based logging systems. From the 1890s through 1936, most if not all of the remaining saw (merchantable) timber was removed from the Basin. What remained was a scattering of second growth trees that grew in after the 1870s-1890s logging and the non-merchantable trees left after sawtimber removal from the 1890s-1936 (Knowles, 1942, Myrick, 1992, Wilson, 1992). The Forest Service purchased the land in 1936. Trees remaining in 1936 became some of the legacy trees seen in the Basin today. Since 1936, there have been some logging and salvage operations conducted by the Forest Service, most notably post-fire salvage logging in the 1960s, the Golden Timber Sale in 1988, the Sagehen Salvage Sale in 1990, and the Sagehen and Spring Chicken Fuel Breaks in 1998 and 2002 respectively. Since the early 1900s, fire suppression policy has excluded most wildfire from the area. The mean historic fire return interval ranged from 10 to 30 years and the current fire return interval ranges from 50 to 95+ years. Generally, the stands that were not affected by stand replacing fire in the last century, but are a consequence of fire suppression, historic logging and some recent vegetation management will be referred to as “Natural Developed Forests” (**NDF**) in this report.

In 1926, the Independence Fire burned 2,653 acres within the Sagehen Basin. Reforestation efforts in the 1970s resulted in a 207 acre mostly Jeffrey pine plantation. In 1960, the Donner Ridge Fire burned 44,812 acres; approximately 1,600 of those were within the Sagehen Basin. Reforestation efforts after the fire resulted in approximately 1,140 acres of plantations consisting mostly of Jeffrey pine within the Sagehen Basin, of which 519 acres are under contract for treatment, while the remaining 621 acres are not. It is unknown where the seedling stock came from for any of the Sagehen Basin plantations; it was not from a local seed source, is likely from a limited genetic pool, and it is highly unlikely to be from an appropriate seed zone or elevation range. Approximately 828 acres of these plantations are being analyzed for treatment under the Sagehen Project. Even aged stands consisting mostly of Jeffrey pine at this scale are unnatural for the area, which would normally be dominated by a mix of other species, ages and genetics. In addition to plantations, several hundred acres were affected by higher severity fire where only a few remnant over story trees survived from the Donner Ridge Fire and that naturally reseeded. These areas progress somewhat differently than plantations, but still remain vulnerable to stand replacing disturbances because they occur in relatively larger sizes. In areas where there is more active fire, much smaller patches of naturally regenerating early seral forests would have been created. Approximately 221 acres of these natural young forests are being analyzed for treatment under the Sagehen Project. Generally, stands that have been affected by higher severity fire in the last century, but have naturally regenerated will be referred to as "Natural Young Forests" (**YF**) in this report, while stands that have been affected by stand replacing fire in the last century, but have been planted will be referred to as "Plantations" (**P**).

This overall disturbance history is evident in much of the planted and natural stands in the Sagehen Project Area and is represented when analyzing several factors. First, study of USGS survey data from the early 1900s indicates the proportion of true fir basal area has increased 10 to 20 percent, while the proportion of yellow and sugar pines have decreased by a similar amount across the Sierra Nevada (McKelvey and Johnston 1992). The trend towards more shade-tolerant species is ongoing. Further, the majority of the basal area across all stands resides in smaller trees (less than 20 inches diameter at breast height - dbh). This results in more competition among smaller, less resilient trees. Also, all stands are relatively homogeneous in terms of structure, basal area, canopy cover and mortality. Although there are substantial changes between some stands of trees, the scale of that variability is not what would have developed under more active conditions within the Sagehen Project Area. More precise measurements of stand conditions are described under direct and indirect effects.

Management direction for the Sagehen Project will follow the *Tahoe National Forest Land and Resource Management Plan* (1990) as amended by the Sierra Nevada Forest Plan Amendment Record of Decision (2004) (these will be referred to as the Forest Plan throughout the remainder of this document).

II. Silviculture Goal

Creating heterogeneous forest stand conditions that would be expected to develop with active fire conditions under an active fire regime

Past large uncharacteristically severe wildfires (specifically the Donner Ridge and Independence), combined with reforestation efforts 50 years ago, have resulted in the extensive plantations consisting mostly of Jeffrey pine and naturally seeded early seral forests that currently occupy the southeastern, northeastern, and northwestern areas of the Sagehen Basin. Dense second growth conifer stands occupy much of the remainder of the Basin and fire has been excluded from these natural stands for decades. Past fires, reforestation, timber harvesting, and fire exclusion have combined to create today's simplified, relatively homogenous structure of the plantations and many of the Basin's forest stands.

Active fire conditions have inherently short fire return intervals that create a set of circumstances on the landscape including, but not limited to, an overall decrease in fire severities and an overall increase in variability at relatively small scales resulting in stand heterogeneity. A fire regime is a general classification of the role fire would play across a landscape in the absence of modern human mechanical intervention, but including the influence of aboriginal burning (Agee 1993, Brown 1995). The majority of the Sagehen Basin is classified as fire regime one, which is considered the most active of all fire regimes. Therefore, the Sagehen Basin historically developed with active fire. However, a century of fire suppression has altered how fire would have affected forest stands and has not created active fire conditions in areas with an active fire regime.

In addition, the structure and tree species composition of the plantations, natural young forests and many of the Basin's developed forest stands have made them vulnerable to a host of mortality factors, including drought stress, bark beetle outbreaks, disease, and the ramifications of climate change. Excessive tree mortality can have significant and long-term effects on forest structure and composition, and these conditions can exacerbate the threat of severe fire. Action is needed to develop forest stands that can be more resilient to this array of threats. Enhancing active fire conditions and forest heterogeneity at the site, stand and landscape scale; reducing stand densities in certain locations; and modifying tree species composition, for example, favoring more fire resilient pines on south facing slopes, could increase overall resiliency. Reducing stand densities would result in less competition for soil moisture resources and light, which would help accelerate the development of stands comprised of larger trees. By creating a landscape that is more heterogeneous and is representative of active fire conditions, remaining trees and stands would be better able to cope with drought stress, insect infestation, and disease outbreaks. Climate change is anticipated to aggravate these stressors; hence, action is needed to enable stands in the Sagehen Basin to be more resilient under expected future conditions.

III. Alternatives Analyzed in Detail

ALTERNATIVE 1 (PROPOSED ACTION)

Emphasis Area Creation

Forest resiliency depends on variability and in order to meet Sagehen Project goals, it was important to find ways to imbed that variability at multiple scales during project design. For example, specific prescriptions and treatment methods can manage for some variability at smaller scales, but it didn't necessarily account for landscape level heterogeneity that has been observed in other fire dependent ecosystems with minimal human intervention. As Underwood explains in "Using Topography to Meet Wildlife and Fuels Treatment Objectives in Fire-Suppressed Landscapes", "Studies using fire history and tree age information have reconstructed nineteenth century forest landscape conditions under frequent fire conditions. These studies have found forest structure and composition varied with topography at both stand and landscape scales (Taylor and Skinner 2004; Hessburg and others 2007). Soil depth also often varies with topography in the Sierra Nevada. Many soils are formed from decomposed granitic parent material, where water holding capacity and site productivity are directly related to soil depth (Giger and Schmitt 1983; Urban and others 2000). This topographic variation in soil depth affects habitat conditions such as tree composition, density and canopy cover (Meyer and others 2007). Forests located higher on slopes and more southwesterly aspects are typically open, pine-dominated forests, in contrast to the higher stem density and canopy cover found in fir-dominated canyons and northeastern aspects" (Underwood et al 2010). In order to reintroduce some of the vegetative variability across the Sagehen Project Area, proven Geographic Information System (GIS) tools (Underwood et al 2010), were used to parse out the landscape according to topography and vegetative conditions. This analysis, not only allowed the Sagehen Project planning effort to weigh individual project goals against a particular place on the landscape, but it also allowed the silvicultural prescription to vary according to a particular unit's location on the slope instead of just relying on its current vegetative status. Ultimately, this method not only allows for more variability at the landscape scale, but also facilitates prescriptions that mimic more natural processes according to its position on the landscape.

Sagehen Project Area Map

Each emphasis area is represented by a different color on the proposed action Map (Map 1). These colors translate into subunits within the proposed treatment unit boundaries. For example, in treatment unit 38, the two discontinuous green areas are both emphasis area 1 and they are both designated subunit 38-1. In another example, treatment unit 213 is comprised of emphasis areas 1 (green), 2 (blue), 4 (fuchsia), 5 (gray), 6 (orange), and 7 (yellow). It therefore has subunits 213-1, 213-2, 213-4, 213-5, 213-6, and 213-7.

Emphasis Area 1

Emphasis area 1 generally represents north facing slopes, but in order to accommodate other project goals, vegetative conditions were incorporated into this emphasis area which grouped some topographic features together. Therefore emphasis area 1 (green areas on Map 1) is predominantly north facing slopes, but does include some ridges, and some higher elevation south facing slopes (above 6,725 feet). Within the treatment units, approximately 453 acres are identified as emphasis area 1 (see Table 1 below)

Emphasis Area 3

Emphasis area 3 represents south facing slopes, but in order to accommodate other project goals, vegetative conditions were incorporated into this emphasis area which created a small, but unique condition set. Because emphasis area 3 is very limited in total area, it was combined with either emphasis area 1 or emphasis area 2 whichever was closer. Therefore there is no mapped emphasis area 3 and there are no metrics assigned to it. Because numbers were already assigned to emphasis areas when emphasis area 3 was combined with others, re-numbering was not done. This discussion is intended to reduce confusion as to why emphasis area 3 is not shown on the map and why it will not be discussed further in this document.

Emphasis Areas 2 and 4

Emphasis areas 2 (blue areas on Map 1) and 4 (fuchsia areas on Map 1) include the drainage bottoms. In order to accommodate other project goals, vegetative conditions were incorporated into the analysis of these two emphasis areas which parsed them accordingly. So although there are different current vegetative conditions in each emphasis area, they both reside in drainage bottoms and could potentially support similar amounts and types of vegetation. These areas include perennial stream courses, meadows, and other intermittent and ephemeral drainages throughout the Basin. These locations tend to be relatively more mesic, retain moisture longer through the season and generally support more dense and diverse vegetation conditions than the surrounding stands. They tend to have more herbaceous vegetation cover and microhabitats. By contrast, some drainages tend to be relatively more xeric and have fewer to no adjoining wet meadows or similar features. Under these conditions these areas still retain moisture for a longer period of the year than surrounding stands and tend to support denser vegetation and often larger trees. Within the treatment units, approximately 103 acres are identified as emphasis area 2 and 173 acres are identified as emphasis area 4 (see Table 1 below).

Emphasis Area 5

Emphasis area 5 (gray areas on Map 1) represents north facing slopes. Due to the more northerly exposure, emphasis area 5 would support more basal area and canopy cover as compared to ridges and south facing slopes. However it would support less basal area and canopy cover than drainages, because of the more xeric conditions. Within the treatment units, approximately 1,028 acres are identified as emphasis area 5 (see Table 1 below).

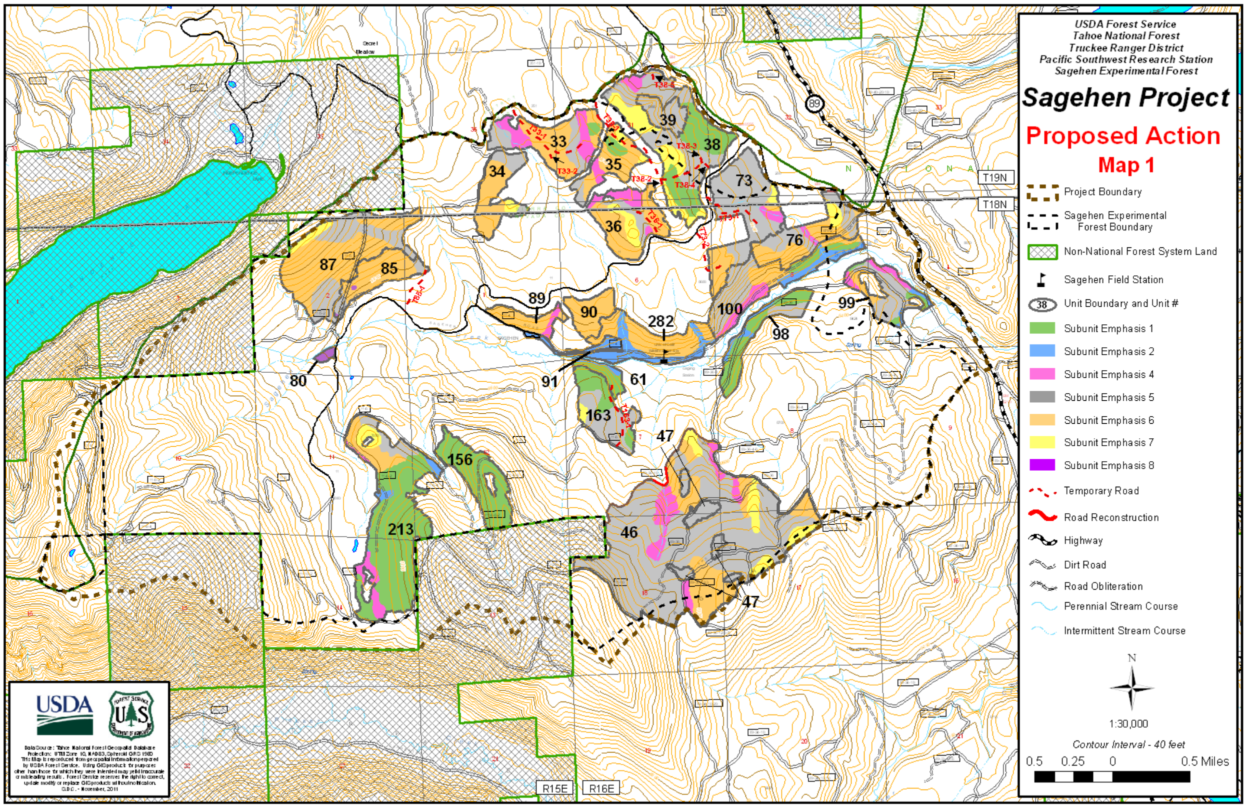
Emphasis Areas 6 and 7

Emphasis area 6 (orange areas on Map 1) represents south facing slopes and emphasis area 7 (yellow areas on Map 1) represents ridges. Overall, emphasis areas 6 and 7 would potentially support less basal area and canopy cover than in emphasis areas 1-5, with ridges (emphasis area 7) potentially supporting the least. Within the treatment units, approximately 740 acres are identified as emphasis area 6 and 150 acres are identified as emphasis area 7 (see Table 1 below).

Emphasis Area 8

Emphasis area 8 (purple areas on Map 1) is unique in that only vegetative conditions were used to demarcate the emphasis area. The vegetation condition focus was on aspen stands with conifer encroachment that reside within treatment unit boundaries. This emphasis area does not represent all aspen stands within the Basin. Within the treatment units, approximately 6 acres are identified as emphasis area 8 (see Table 1 below).

Map 1: Proposed Action Map



Order of Prescription Application

Implementing the following silvicultural prescriptions involves careful consideration of fire: both the follow-up application of fire/fuels prescriptions as well as the stand structure conditions that would likely develop under active fire conditions. On-the-ground decisions about which individual trees and groups of trees to retain are made in light of (1) ensuring overall stand structure will remain intact following application of prescribed fire and (2) mimicking stand structures that would develop under active fire conditions.

The prescriptions can be highly variable and site-specific, and are set within the context of the existing stand's structure, tree species composition, and as compared to the emphasis area objectives for each subunit. For most units within the Sagehen Project, implementing the following silvicultural prescriptions involves applying each of the first five prescriptions in a step-wise fashion:

- The first step involves identifying both the dense cover areas (DCAs) and early seral openings (ESOs), and laying out their boundaries out on the ground.
- Next, the trees suitable for legacy tree treatments are identified and the surrounding trees proposed for removal are marked.

- After this is done, the variable thinning mark is anchored to DCAs, ESOs, and legacy tree treatments.
- In addition, the suppressed cut prescription is applied to remove suppressed trees contributing to ladder fuels outside of DCAs.
- Finally in subunits where the current snag/short snag densities are substantially below desired densities, decadent feature enhancements (partial tree girdling and/or short snag creation) would be identified for implementation either by machinery or hand.

All five of these prescriptions would be applied, in a step-wise fashion, for each identified unit (see Table 1). If there are no trees suitable for legacy tree treatment in a given unit, that prescription would be dropped during marking. The remaining two prescriptions, plantation thinning and aspen restoration are applied specifically to plantations and aspen stands, respectively.

The following activities are proposed (summarized in Table 1):

Table 1: Proposed Activities

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Silvicultural Rx – *see Order of Prescription Application section above*	Silvicultural Treatment Method	Fire/Fuels Rx	Fire/Fuels Treatment Method
33	118	1	4	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Pile Burn Rx	Grapple Pile Pile Burn
		4	30				
		5	28				
		6	56				
34	68	5	16	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Surface Fire Rx	Underburn
		6	47				
		7	5				
35	64	1	8	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Pile Burn Rx	Grapple Pile Pile Burn
		4	6				
		5	7				
		6	37				
		7	6				
36	101	4	18	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Pile Burn Rx	Grapple Pile Pile Burn
		5	13				
		6	56				
		7	14				
38	210	1	67	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent	Mechanical	Surface Fire Rx	Underburn
		4	7				
		5	86				
		7	50				

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Silvicultural Rx – *see Order of Prescription Application section above*	Silvicultural Treatment Method	Fire/Fuels Rx	Fire/Fuels Treatment Method
				Feature Enhancement			
39	32	5	32	No Treatment	N/A	Surface Fire Rx	Underburn
46	621	4	47	No Treatment	N/A	Surface Fire Rx	Underburn
		5	431	Plantation Thin	Mechanical Mastication	Lop & Scatter Surface Fire Rx	Mastication Underburn
		6	105				
		7	38				
47	33	5	33	No Treatment	N/A	Surface Fire Rx	Underburn
61	20	1	15	Variable Thin, Suppressed Cut, Dense Cover Area	Hand	Pile Burn Rx Surface Fire Rx	Hand Pile Pile Burn Underburn
		2	5				
73	144	4	6	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Surface Fire Rx	Underburn
		5	107				
		6	27				
		7	4				
76	91	4	4	No Treatment	N/A	Surface Fire Rx	Underburn
		5	37	Plantation Thin	Mechanical Mastication	Lop & Scatter Surface Fire Rx	Mastication Underburn
		6	42				
		7	8				
80	5	8	5	Aspen Restoration	Hand	Pile Burn Rx	Hand Pile Pile Burn
85	64	5	10	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical Mastication	Lop & Scatter	Mastication
		6	53				
		8	1	Aspen Restoration	Mechanical	N/A	N/A
87	207	5	67	Plantation Thin	Mechanical Mastication	Lop & Scatter	Mastication
		6	130				
		7	10				
89	34	4	6	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Surface Fire Rx	Underburn
		6	28				
90	40	6	40	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Surface Fire Rx	Underburn
91	9	2	9	Variable Thin, Suppressed Cut, Dense Cover Area	Hand	Pile Burn Rx	Hand Pile Pile Burn
98	63	1	43	Variable Thin,	Hand	Pile Burn Rx	Hand Pile

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Silvicultural Rx – *see Order of Prescription Application section above*	Silvicultural Treatment Method	Fire/Fuels Rx	Fire/Fuels Treatment Method
		2	9	Suppressed Cut, Dense Cover Area			Pile Burn
		5	11				
99	67	1	7	Variable Thin, Suppressed Cut, Dense Cover Area	Hand	Pile Burn Rx	Hand Pile Pile Burn
		2	4				
		4	11				
		5	37	Plantation Thin	Mechanical Mastication	Lop & Scatter	Mastication
		6	8				
100	120	1	14	Variable Thin, Suppressed Cut, Dense Cover Area, Decadent Feature Enhancement	Hand	Pile Burn Rx Surface Fire Rx	Hand Pile Pile Burn Underburn
		2	19				
		4	17				
		5	46				
		6	24				
156	84	1	84	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening	Mechanical	Pile Burn Rx	Grapple Pile Pile Burn
163	82	1	29	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Pile Burn Rx Surface Fire Rx	Grapple Pile Pile Burn Underburn
		5	49				
		7	4				
213	268	1	182	Variable Thin, Legacy Tree Treatment, Suppressed Cut, Dense Cover Area, Early Seral Opening, Decadent Feature Enhancement	Mechanical	Pile Burn Rx	Grapple Pile Pile Burn
		2	11				
		4	21				
		5	18				
		6	25				
		7	11				
282	108	2	46	Variable Thin, Suppressed Cut, Dense Cover Area	Hand	Pile Burn Rx Surface Fire Rx	Hand Pile Pile Burn Underburn
		6	62				

Prescription and Treatment Method Definitions (associated treatment areas):

Silvicultural Prescriptions

Dense Cover Areas (DCAs) and Early Seral Openings (ESOs)

Units: 33, 34, 35, 36, 38, 61, 73, 89, 90, 91, 98, 100, 156, 163, 213, 282 (all emphasis areas), 85 – emphasis areas 5 and 6, and 99 -emphasis areas 1, 2 and 4.

Dense cover areas (DCAs) are small areas distributed within treatment units that provide continuous vertical and horizontal cover with a mixture of shrubs and trees along with large and small down wood, snags, and high stumps. DCAs would typically contain clumps of trees of various size classes as well as a variety of snag and down wood sizes. These existing DCAs, ranging in size from 0.25-1 acre, would contribute to/enhance within-stand horizontal and vertical structural diversity and provide important old forest and/or mid seral habitat elements. For example existing DCAs can be representative of multiple layered late seral conditions with high levels of decadence and dead wood. They can also represent a more mid seral condition with brush and a medium sized tree overstory. ESOs would be comprised of dense young regenerating trees and/or shrubs to provide early successional habitat within larger stands managed for late successional or old forest habitat. ESOs, from 0.25-0.50 acre, would enhance within-stand age and species diversity. In some cases, there can actually be a mix of DCAs and ESOs such as around fens. For example, some DCAs are planned around small fens in units 46, 85, and 98. The area would encompass not only the fen but also some of the surrounding forest stand. Both vertical structural diversity and an early seral stage would be represented.

Two primary methods would be used to retain and create DCAs or ESOs: For DCAs, an area would be designated that has multiple structural elements, such as large down woody material, a mixture of tree age classes (including solitary and groups of large trees), large snags, multiple tree canopy layers; and/or trees with features associated with wildlife use (for example, platforms, mistletoe brooms, forked tops, and cavities). No mechanical tree removal would be conducted in these “existing DCAs”. For ESOs, by taking advantage of existing conditions, such as areas of sparse tree cover, thinner soils, or pockets of extensive tree mortality, openings would be created by removing most or all of the existing trees and either planting or allowing natural shrub and/or tree regeneration to create an ESO of early successional habitat.

Prescribed fire would be an important management tool within DCAs and ESOs. For DCAs comprised of multiple sizes of trees, snags, and down wood, prescribed fire would be carefully applied to maintain key habitat elements, particularly snags and down wood. While underburning in DCAs would likely result in some mortality of suppressed and subdominant trees, burning prescriptions would be designed to ensure the overall structure of the DCA would remain intact. For ESOs (regeneration areas), prescribed fire would be applied to regenerate shrubs and create suitable areas for shade-intolerant tree species to regenerate.

Although the emphasis areas listed will have some combination of DCAs and ESOs, this treatment is proposed on about 6 percent of the total project acres. Further, the lower the emphasis area number, the higher percentage of DCAs compared to ESOs is proposed for treatment, while the higher the emphasis area number, the higher percentage of ESOs compared to DCAs is proposed for treatment. This deliberate configuration corresponds to what might have existed within the emphasis areas under active fire conditions under an active fire regime. For example, Unit 38 – emphasis area 1 has 14 acres of DCA/ESOs proposed for treatment where ten of those acres (70 percent) are comprised of DCAs. Unit 36 – emphasis area 6 has five acres of DCA/ESOs proposed for treatment where three acres (60 percent) are comprised of ESOs.

Table 2: Acres of Proposed DCA/ESO Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Dense Cover Area Acres	Early Seral Opening Acres
33	118	1	4	1.08	0
		4	30	3.03	0
		5	28	2.28	2.02
		6	56	1.85	4.07
34	68	5	16	1.46	.93
		6	47	1.36	1.98
		7	5	0	.53
35	64	1	8	1.47	0
		4	6	.58	0
		5	7	.48	.54
		6	37	1.03	2.04
		7	6	0	.32
36	101	4	18	2.64	0
		5	13	1	.36
		6	56	1.89	3.27
		7	14	0	1.08
38	210	1	67	7.5	3.3
		4	7	.48	0
		5	86	4.96	4.09
		7	50	0	3.02
39	32	5	32	0	0
46	621	4	47	0	0
		5	431	0	0
		6	105	0	0
		7	38	0	0
47	33	5	33	0	0
61	20	1	15	2	0
		2	5	.5	0
73	144	4	6	1.03	0
		5	107	5.86	4.36
		6	27	.47	1.59
		7	4	0	.48
76	91	4	4	0	0
		5	37	0	0
		6	42	0	0
		7	8	0	0
80	5	8	5	0	0
85	64	5	10	.69	.44

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Dense Cover Area Acres	Early Seral Opening Acres
		6	53	1.92	2.34
		8	1	0	0
87	207	5	67	0	0
		6	130	0	0
		7	10	0	0
89	34	4	6	.6	0
		6	28	1.13	1.4
90	40	6	40	1.12	1.21
91	9	2	9	.5	0
98	63	1	43	7	0
		2	9	.5	0
		5	11	.5	0
99	67	1	7	1	0
		2	4	.5	0
		4	11	1	0
		5	37	0	0
		6	8	0	0
100	120	1	14	2	0
		2	19	1	0
		4	17	3.5	0
		5	46	1.5	0
		6	24	1.5	0
156	84	1	84	6.19	2
163	82	1	29	4.18	1.95
		5	49	2.72	2.08
		7	4	0	.5
213	268	1	182	15.83	5.6
		2	11	1.03	0
		4	21	3.07	0
		5	18	.86	1.02
		6	25	.91	.87
		7	11	0	1
282	108	2	46	2.5	0
		6	62	3.5	0
Totals				110	54

Legacy Tree Treatment

Units: 33, 34, 35, 36, 38, 73, 89, 90, 156, 163, 213 (all emphasis areas), and 85- emphasis areas 5 and 6.

Legacy trees are the largest and/or oldest trees within a stand. A legacy tree is a large tree (typically greater than 24 inches dbh) that has remained on site while most of the original surrounding trees have been removed by either timber harvest or mortality due to fire, insects, drought, or disease. Hence, a legacy tree tends to be at least a generation older than the trees in the surrounding stand and is one of the largest trees in the stand. Legacy trees can occur singly or in groups, and often represent tree species that would occur under active fire conditions under an active fire regime.

Legacy trees are not present within every stand, and, as a general rule, are somewhat rare in the Sagehen Project Area's forest stands, typically occurring at a density of one to two legacy trees per five acres. As with many other forest structural features, this value varies considerably depending on site history and conditions.

As stated above, the legacy tree treatment prescription is applied after the DCAs and ESOs are identified. In some cases legacy trees may occur within a DCA. In this case the DCA trumps the legacy tree treatment and trees surrounding the legacy tree are retained in the DCA. In other cases, a legacy tree may occur on the edge of an ESO. In this case, the ESO would be designed to, in effect, implement a partial legacy tree treatment in that trees removed in the ESO would also be trees that would have been removed in the legacy tree treatment. Legacy tree treatments would not be used to expand the resulting sizes of ESOs.

In some of the Project Area plantations, there are trees that survived the wildfires and subsequent salvage harvest, in these cases the trees are referred to as "residual" trees. While they do meet the definition of legacy trees, they occur in large enough groups that they would be treated differently than individual or small groups of legacy trees, see the Plantation Thinning prescription below.

Legacy tree treatment would involve removing trees up to 30 inches dbh around the legacy tree, however, existing stand structure would dictate the sizes of trees (up to a 30 inch dbh limit) to be removed. For example if the legacy tree was 28 inches dbh, trees up to 28 inches dbh could be removed, or if the legacy tree was 40 inches dbh and it was surrounded by 34 inches dbh trees, the largest tree that would be removed is 29.9 inches dbh. In no cases would trees be removed that are larger than 30 inches dbh, and trees larger than the legacy tree would not be removed. Legacy tree(s) typically occur as individuals when they are pines and occur in small (2-5 tree) clumps when they are firs.

This treatment is designed to increase the resiliency of large legacy trees from the effects of fire, drought, pathogens, and disease. Removing trees from around the legacy tree(s) accelerates tree root and diameter growth, thereby improving overall legacy tree health and resiliency. In addition, the removal of smaller, understory trees, particularly the shade tolerant, less fire-resistant white fir, removes ladder fuels, which could carry fire into the canopy of the legacy tree(s).

The distance of the tree removal around legacy tree(s) would be variable, based on site-specific conditions (such as extent of the drip line, aspect, and topography). For example, legacy tree(s) on slopes greater than 25 percent could have a treatment distance that extended approximately one and one-half tree lengths. In flatter areas, treatment distances could be shorter as flame lengths would be lower compared to those occurring on steeper slopes. Differences also arise on north facing versus south facing slopes. Treatment distances would typically be smaller on north facing slopes. In addition, treatment distance could be longer on the south side of the legacy tree versus the north side of the tree, based on expected topographic effects of the sun. Although varying conditions would dictate a range of proposed tree removal under and around legacy trees, the majority of legacy tree treatments would not extend beyond a half a tree length from the drip line of the tree and would rarely hold a consistent distance from the tree. For example the north side of a legacy tree may only be cleared to the drip line (removal of ladder fuels), while the south side of the tree may extend a half a tree length further. On the rare occurrences where topographic conditions could increase flame lengths from surrounding trees (i.e. a legacy tree at the high end of a 35 percent slope) treatments may extend as much, but no further, than a tree and half-length only on the downhill side from the bole of the legacy tree. If this situation does occur and the size of that treatment exceeds 0.25 of an acre, then this treatment will also be accounted for as an early seral opening (ESO).

Variable Thinning

Units: 33, 34, 35, 36, 38, 61, 73, 89, 90, 91, 98, 100, 156, 163, 213, 282 (all emphasis areas), 85- emphasis areas 5 and 6, and 99 emphasis areas 1, 2, and 4.

The variable thinning prescription is highly site-specific, set within the context of the existing stand's structure and tree species composition. In general, variable thinning involves selective removal and retention of individual codominant and subdominant trees and/or small groups of codominant and subdominant trees. Variable thinning would occur throughout the areas outside of dense cover areas, early seral openings, and legacy tree treatment areas, varying by the prescriptions designed for each emphasis area. Thinning would be conducted to meet treatment subunit level objectives of basal area, canopy cover, tree species composition, and fire behavior (as described under "Prescription Metrics" below), and to increase stand level structural heterogeneity. As stated above, and especially for a variable thinning prescription, implementation involves careful consideration of fire: both the follow-up application of prescribed fire, as well as the stand structure conditions that would likely develop under active fire conditions. On-the-ground decisions about which individual trees and groups of trees to retain would be made in light of (1) ensuring overall stand structure would remain intact following application of prescribed fire and (2) mimicking stand structures that would develop under active fire conditions.

Variable thinning objectives include: (a) enhancing stand heterogeneity (by retaining groups of larger trees that can provide valuable wildlife habitat and creating subtle openings by thinning around these groups), (b) reducing fuels, and (c) work towards stand level ecological restoration. *An Ecosystem Management Strategy for Sierran Mixed-Conifer Forests* (North et al. 2009), also referred to as General Technical Report (GTR) 220 presents a comprehensive overview of the recent scientific literature regarding mixed conifer stands in the Sierra Nevada and its bearing on forest management approaches. The Report's recommendations are aimed at enhancing forest resiliency, increasing stand and landscape scale heterogeneity, restoring the ecological role of fire to the landscape, and maintaining habitat for sensitive wildlife species in Sierra Nevada mixed conifer forests. The variable thinning approach is based on the GTR 220 principle that varying stem density according to potential fire intensity effects on stand structure can create horizontal heterogeneity inherent to these landscapes. As such, the variable thinning primarily focuses on removing ladder fuels, subdominant and codominant shade-tolerant trees (such as white fir), and some subdominant and codominant shade-intolerant trees (such as Jeffrey or ponderosa pine). It is not based on spacing guidelines but rather works within the context of the existing stand to emphasize the retention of desired tree species compositions, basal areas, and desired stand structure elements (such as trees with some level of decadence or "defect").

Variable thinning would be applied using the following guidelines:

- Generally favor retention of pines over firs, especially in southerly facing areas and on ridges. In areas of more fir dominance, give retention preference to red fir over white fir. Retained groups of larger trees (described under the bullet below) may include fir trees. Overall the emphasis for retained groups of trees is preserving or enhancing desirable stand structure rather managing for any particular species composition.
- Retain groups of larger trees, generally comprised of five to ten (or more) trees of roughly similar size. Ideally, some of the retained trees should have desirable habitat features, such as forked or broken tops. Remove trees adjacent to these retained groups to improve the overall health and resiliency of the group to drought, insects and disease.
- Where a few (less than five) trees occur together, or where trees are scattered, retain the more vigorous trees by removing subdominant and, in some cases, codominant trees around them to reduce ladder fuels and competition for light, water, and nutrients.
- In areas of greater fir dominance where large trees tend to grow in more of a clumped nature, emphasize retaining clumps, or groups, of generally five to ten trees, and removing trees adjacent to these retained clumps to create small, variably shaped gaps.
- When making site-specific determinations on individual tree removal/retention preferences, vary the choices made so as to increase the variability at the micro-site scale.

Suppressed Cut

Units: 33, 34, 35, 36, 38, 61, 73, 89, 90, 91, 98, 100, 156, 163, 213, 282 (all emphasis areas), 85- emphasis areas 5, 6, and 99- emphasis areas 1, 2, 4.

A suppressed tree is typically no larger than ten inches dbh (usually ranging between one and five inches dbh) *and* is a component of a stand's understory, where there is an overstory of dominant, codominant, and subdominant trees. Suppressed trees, in general, have little capacity to release (initiate increased growth rates), even if the overstory is removed. These trees often make up the lower levels of ladder fuels, and the suppressed tree layer combined with subdominant trees helps connect the forest floor into the crowns of dominant/codominant trees, which can increase fire severity and the potential for crown fire.

The suppressed cut would remove suppressed trees (down to one inch dbh for hand thinning and down to three inches dbh for mechanical thinning), as described above, within treatment units outside of dense cover areas. The suppressed cut prescription would not be applied within dense cover areas. This would retain a percentage of the suppressed tree size class within the treatment units, enhancing within-stand variability from a tree size standpoint. Suppressed tree removal outside dense cover areas would facilitate use of prescribed fire while helping to minimize the risks of crown fire by removing some ladder fuels.

Although the suppressed cut prescription is proposed to remove the majority of trees less than ten inches dbh outside of dense cover areas, the amount of dense cover areas, the variable thin prescription and the limited treatment in emphasis area 4 of the plantation thinning prescription (see below) will more than meet Forest Plan requirements of retaining at least five percent of trees between six and 24 inches dbh within the project area.

Plantation Thinning

Units: 87 (all emphasis areas), 46- emphasis areas 5, 6, and 7, 76- emphasis areas 5, 6, and 7, and 99- emphasis areas 5 and 6.

Plantations in the Sagehen Project Area were established in the 1960s and 1970s following the Independence and Donner Ridge wildfires. The plantations are largely comprised of planted Jeffrey and some ponderosa pines; however, they also contain young trees that grew in naturally. The plantation thinning prescription is designed to facilitate and accelerate the continued growth of these young trees. The plantations currently contain some trees that survived wildfire and subsequent salvage harvest: these “residual” trees would not be removed. While they do meet the definition of legacy trees, residual trees in plantations would be treated differently than individual or small groups of legacy trees with a focus on removing ladder fuels to protect them during prescribed burning treatments. There also would be an emphasis on removing ladder fuels on the downhill sides of the residual trees where steep slopes may contribute to flame lengths reaching the residual trees.

Plantation thinning would involve mechanical thinning and/or mastication (mechanical grinding and crushing that *rearranges* material on site) of plantation trees and mastication of brush. Mastication changes a vertical large piece of fuel (i.e. a standing tree) into many smaller pieces of horizontal fuel. This is termed “*rearranging”* the fuels to a condition that allows the material to decompose more rapidly. The plantation thinning prescription would primarily focus on removing and/or rearranging trees between one and 12 inches dbh. An occasional tree between 12 and 18 inches dbh could be removed; however, this would occur only where mechanical cutting and removal systems were used. The majority of trees between 12 and 18 inches dbh would be retained. Because of the nature of plantations and the logistics of marking trees in extremely dense brush, trees would be thinned by description and a spacing guideline would be applied. Typically, retained trees would be spaced roughly 14 to 22 feet apart; however, where logistically possible, existing variable stand structure would be used to increase within-stand horizontal heterogeneity such that there would be some more dense and more open areas.

Plantation thinning would retain at least 120 trees per acre. Sufficient tree canopy cover would be maintained to suppress shrub growth under groups of trees; however, retarding shrub growth over the entire treatment unit would not be a specific objective. Although the primary objective of plantation thinning is to accelerate the growth of retained trees, a secondary objective is to foster some within-stand defect trees. To meet this secondary objective, plantation thinning would retain an average of ten to 12 trees per acre with injuries, split tops, and/or porcupine damage.

Shrubs growing under the drip line of retained trees would be masticated. Other areas of snow brush, manzanita, and white thorn outside the drip lines would also be masticated to decrease the fire hazard and provide opportunities for brush regeneration. Further, patches of bitterbrush and *Ribes* outside of tree drip lines would not be masticated unless they posed a fire hazard (ladder fuels) to retained trees/groups of trees. Bitterbrush is a preferred browse species for mule deer and it occurs in some homogeneous small patches in the plantations. These patches provide valuable foraging habitat. Because bitterbrush and *Ribes* do not regenerate (stump sprout) very well after mastication, unless posing a direct ladder fuels hazard, these species would not be masticated.

In addition to spacing guideline ranges, other measures would be implemented to increase within-stand horizontal heterogeneity. Where less than ten trees per acre are present, no trees would be thinned and shrubs would not be masticated; however, these areas could be underburned. Because the plantations are largely composed of Jeffrey and ponderosa pines, species preference for retention would focus on other species, if they are present. This could mean that a larger pine would be proposed for removal/mastication if it is in close proximity to a tree of another species, such as red fir.

Areas containing “residual” trees as well as areas that currently have less than ten trees per acre, which would not be mechanically thinned or masticated, would serve functions similar to DCAs and ESOs in the treated plantations. In addition, identified drainage bottoms within plantations would not be treated, providing additional areas like DCAs. Based on existing conditions in the plantation treatment units, it is estimated that at least ten percent of the overall plantation acreage would be included in these residual tree zones, sparsely treed areas, and drainages. These areas would enhance heterogeneity in the treated plantations.

Aspen Restoration

Units: 80- emphasis area 8, and 85- emphasis area 8.

An aspen restoration prescription involves selectively removing conifers from stands of aspen that are at risk of loss because they are being crowded and shaded by thickets of small lodgepole pine or they are being overtopped by conifers. These stands typically have a much higher percentage of conifers than aspen, and have little aspen regeneration. Conifer removal would occur by hand cutting or mechanical cutting methods. When treated by hand, typically most conifers from one to 16 inches dbh would be cut and removed from site and larger conifers girdled to create snags. When treated by mechanical means, conifers greater than three inches dbh that are overtopping and/or crowding aspens would be removed.

Decadent Feature Enhancement

Units: 33 – all emphasis areas, 34 – emphasis areas 5 and 6, 35 – emphasis areas 1, 4, 5 and 6, 36 – emphasis areas 4, 5, and 6, 38 – emphasis areas 1, 4, and 5, 73 – emphasis areas 4, 5, and 6, 85 – emphasis areas 5 and 6, 89 – all emphasis areas, 90 – all emphasis areas, 100 – emphasis areas 1 and 2, 163 – emphasis areas 1 and 5, 213 – emphasis areas 1, 2, 4, 5 and 6.

This prescription encompasses two different treatments; partial tree girdling and short snag creation. Partial tree girdling would occur inside and outside of DCAs and short snag creation would only occur in DCAs. Both treatments would only be applied in subunits where the current snag/short snag densities are substantially below desired densities.

Partial tree girdling would involve girdling (cutting off the bark layer deep enough to sever the tree's vascular system in the cambium) of individual trees 15-30 inches dbh. The bark layer would be removed in a 6-12 inch band covering approximately ⅓ of the diameter of pine trees and ½ of the diameter of fir trees. The goal of this treatment is to selectively wound and therefore weaken trees. These weakened trees would become more susceptible to environmental stresses, insect attack, and/or fungus/rot infection and therefore become snags likely before a neighboring, non-girdled tree would. By partially girdling and wounding trees, it is anticipated that the trees would become snags over a longer timeframe rather than die immediately, like what would happen if a tree were completely girdled.

The selection of trees for partial tree girdling would occur after the DCA and ESO, legacy tree treatment, variable thinning and suppressed cut prescriptions had been applied (marked). Trees selected outside of DCAs for partial girdling would be trees already selected under the variable thinning prescription for removal. Therefore these trees would be accounted for when calculations of basal area removal and trees removed per acre are tallied, however they would be left on site. These trees would be among the largest trees available (under 30 inches dbh). Trees selected for partial girdling in DCAs would be designated based on the site specific conditions in the DCAs and would be trees that would provide needed habitat structure in the DCAs.

Short snag creation involves cutting a tree (preferentially a white fir), on the outside edge, but within a DCA, at a height of 10-20 feet above the ground. The height would be based on the highest point a piece of machinery such as a feller buncher, could reach to cut the tree. The top of the tree would be felled into the interior of the DCA and left to contribute to down log densities. Trees selected for this treatment would be 15-30 inches dbh. The goal of this treatment is to immediately create snags at an intermediate height inside of DCAs. These short snags would be expected to provide suitable perches/rest sites and would be tall enough to be above typical snow levels, thus also providing an access route under the snow for wildlife.

Table 3: Decadent Feature Enhancement Orientation

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	# of Partial Girdled Trees Created outside DCA	# of Partial Girdled Trees Created inside DCA	# of Short Snags Created inside DCA
33	118	1	4	7	1	2
		4	30	0	0	6
		5	28	36	2	4
		6	56	0	2	2
34	68	5	16	0	0	3
		6	47	0	0	2
		7	5	0	0	0
35	64	1	8	6	1	2
		4	6	0	0	1
		5	7	7	1	1
		6	37	0	0	1
		7	6	0	0	0
36	101	4	18	0	0	6
		5	13	20	1	2
		6	56	0	0	1
		7	14	0	0	0
38	210	1	67	0	0	19
		4	7	0	0	1
		5	86	0	0	9
		7	50	0	0	0
39	32	5	32	0	0	0
46	621	4	47	0	0	0
		5	431	0	0	0
		6	105	0	0	0
		7	38	0	0	0
47	33	5	33	0	0	0
61	20	1	15	0	0	0
		2	5	0	0	0
73	144	4	6	0	0	2
		5	107	0	0	16
		6	27	0	0	1
		7	4	0	0	0
76	91	4	4	0	0	0
		5	37	0	0	0
		6	42	0	0	0
		7	8	0	0	0

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	# of Partial Girdled Trees Created outside DCA	# of Partial Girdled Trees Created inside DCA	# of Short Snags Created inside DCA
80	5	8	5	0	0	0
85	64	5	10	11	1	1
		6	53	0	0	2
		8	1	0	0	0
87	207	5	67	0	0	0
		6	130	0	0	0
		7	10	0	0	0
89	34	4	6	0	0	2
		6	28	0	0	1
90	40	6	40	0	0	1
91	9	2	9	0	0	0
98	63	1	43	0	0	0
		2	9	0	0	0
		5	11	0	0	0
99	67	1	7	0	0	0
		2	4	0	0	0
		4	11	0	0	0
		5	37	0	0	0
		6	8	0	0	0
100	120	1	14	48	2	0
		2	19	36	1	0
		4	17	0	0	0
		5	46	0	0	0
		6	24	0	0	0
156	84	1	84	0	0	0
163	82	1	29	0	0	8
		5	49	0	0	5
		7	4	0	0	0
213	268	1	182	237	14	30
		2	11	32	1	2
		4	21	41	3	6
		5	18	32	1	2
		6	25	0	0	1
		7	11	0	0	0
282	108	2	46	0	0	0
		6	62	0	0	0

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	# of Partial Girdled Trees Created outside DCA	# of Partial Girdled Trees Created inside DCA	# of Short Snags Created inside DCA
Totals				**513**	**31**	**142**

Silvicultural Treatment Methods

Mechanical Thinning

Units: 33, 34, 35, 36, 38, 73, 85, 87, 89, 90, 156, 163, 213 (all emphasis areas), 46 - emphasis areas 5, 6, and 7, 76- emphasis areas 5, 6, and 7, 99 - emphasis areas 5 and 6.

Mechanical thinning is a harvest activity, which, under the Sagehen Project would utilize ground-based equipment (tractors, feller bunchers and some chainsaw work) to fell and remove identified trees while retaining and protecting desirable trees to accomplish fuels reduction, marten habitat enhancement and restoration, and stand level ecological restoration objectives set within each treatment unit. A network of skid trails (in the case of ground-based thinning operations), landings, and, in some cases, temporary roads (which are removed following project activities) would be used to transport and collect harvested material. This equipment would operate on slopes generally less than 25 percent. Short pitches less than 150 feet long and up to 30 percent in slope would also be included in treatments using ground based equipment. A borate compound would be applied to all white fir stumps greater than 14 inches in diameter to prevent Annosus root disease.

Hand Thinning

Units: 61, 80, 91, 98, 100, 282 (all emphasis areas), 99 - emphasis areas 1, 2, and 4.

Hand thinning is an activity that utilizes crews with chainsaws or handsaws that cut understory conifers less than 16 inches dbh to accomplish fuels reduction, marten habitat enhancement and restoration, and stand-level ecological restoration objectives set for the treatment unit. If hand felled material contributes to unacceptable fuel loading, this material may be hand piled outside the drip lines of desirable trees and burned when conditions permit a minimum amount of mortality.

Mastication

Units: 87 (all emphasis areas), 46 - emphasis areas 5, 6, and 7, 76- emphasis areas 5, 6, and 7, 85 - emphasis areas 5 and 6, 99- emphasis areas 5 and 6.

A masticator is a low ground pressure piece of equipment that “chews” up brush and small understory trees to reduce competition. The machine mechanically grinds and crushes this material and down woody fuels and distributes the resulting small pieces around the site. This equipment would operate on slopes generally less than 25 percent. Short pitches less than 150 feet long and up to 30 percent in slope would also be included in treatments using ground based equipment.

Mastication is also a Fire/Fuels Treatment Method – see below.

Fire/Fuels Prescriptions

Surface Fire Prescription

Units: 34, 38, 39, 46, 47, 61, 73, 76, 89, 90, 100, 163, 282 (all emphasis areas).

A surface fire is a fire that burns live and dead fuels at or near the surface of the ground, mostly by flaming combustion. A surface fire prescription is usually implemented by an underburn. Surface fire prescriptions are typically designed to consume surface and ladder fuels and to mimic fire that would occur in an active fire regime. Surface fire prescriptions can be applied under spring-like and fall-like conditions. Spring-like conditions are defined by relatively high live fuel moistures, high 1000 hour size ("coarse woody debris", three inches diameter and greater) fuel moistures, and soils that are relatively moist beneath the surface fuels. Under spring-like conditions, it is expected that surface fires would have moderate to high consumption of 1-100 hour size fuels ("fine woody debris", ranging from 0.00-2.99 inches diameter) and minimal consumption of 1000+ hour fuels with mortality primarily expected in subdominant tree size classes. Fall-like conditions are defined by relatively low live fuel moistures, lower 1000 hour fuel moistures, and drier soils with dry organic layers beneath the litter layer. Under fall-like conditions, it is expected that burning would be primarily surface fires with higher flame lengths, and faster burn times as compared to burning under spring-like conditions. It would have high consumption of 1-100 hour size fuels and moderate to high consumption of 1000+ hour fuels, and with mortality expected in subdominant and some codominant tree size classes. Depending on cycles of drought and wet weather, spring-like and fall-like conditions can occur throughout the year. For the Sagehen Project, spring-like condition surface fire prescriptions would be emphasized, however due to limited suitable burning conditions, surface fire prescriptions under fall-like conditions would be implemented in some cases. In these cases, extra measures to protect large dead wood, such as creating firelines around large logs/snags, would be implemented.

Pile Burn Prescription

Units: 33, 35, 36, 61, 80, 91, 98, 100, 156, 163, 213, 282 (all emphasis areas), 99 - emphasis areas 1, 2, and 4.

A pile burn prescription is designed to remove surface fuels, both fuels generated from silvicultural treatments (activity fuels) and existing fuels on the ground. A pile burn prescription can be implemented by hand or by machinery (typically a grapple piler – see below). In general, small down wood is placed in piles for future burning. Pile location and size is dictated by existing conditions, however piles would be preferentially placed outside of sensitive areas such as riparian conservation areas and cultural resource sites. Piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger. This prescription removes surface fuels in the treatment units and is used to mimic underburning where sensitive areas prevent unit-wide application of underburning.

Lop and Scatter

Units: 87 (all emphasis areas), 46 - emphasis areas 5, 6, and 7, 76 - emphasis areas 5, 6, and 7, 85 - emphasis areas 5 and 6, 99 - emphasis areas 5 and 6.

A lop and scatter prescription does not remove fuels from treated areas. It prescribes changing the size and arrangement of the fuels. Lop and scatter prescriptions usually deal with activity generated fuels as a result of tree removal (tree tops and branches), however it can also apply to brush and standing ladder fuels. The purpose of a lop and scatter prescription, by changing the arrangement and size of fuels, is to take the fuels to a condition that allows the material to break down more rapidly.

Fire/Fuels Treatment Methods

Underburning

Units: 34, 38, 39, 46, 47, 61, 73, 76, 89, 90, 100, 163, 282 (all emphasis areas).

Underburning is a generalized term used when applying prescribed fire to large areas and is typically the treatment method for a surface fire prescription. Underburning targets surface fuels, some understory, and, in rare cases, larger trees. Surface fuels are the primary agent of fire spread. The objective is to apply controlled fire under optimum conditions where the treatment can modify fuel conditions to effectively reduce fire behavior and the corresponding intensity of a future wildfire. Within some areas proposed for burning, the goal of the treatment may be to consume a significant portion of the existing surface fuels that could cause high wildfire intensities, and/or the consume understory vegetation (ladder fuels) in order to reduce future fire severity and to create conditions that allow for future prescribed underburning opportunities. In other areas, underburning is used to create new growth of native shrub species and forage opportunities for wildlife. Underburning most closely mimics low-intensity fire that would occur in an active fire regime. Underburning, especially on south and west facing slopes, is typically conducted under spring-like conditions. A more mosaic burn pattern is created by underburning in spring-like conditions as compared to fall-like conditions; with some areas minimally burned and overall less fuel consumption. For the Sagehen Project proposal, underburning would be applied on a unit-wide basis, in other words, where underburning is proposed it would be conducted across the entire treatment unit and across all subunits (emphasis areas) within that treatment unit.

Hand Piling and Burning

Units: 61, 80, 91, 98, 100, 282 (all emphasis areas), 99 - emphasis areas 1, 2, and 4.

After a hand or mechanical thin, residual activity fuels and some naturally occurring fuels are piled by hand into burn piles. Hand piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger.

Grapple Piling and Burning

Units: 33, 35, 36, 156, 163, 213 (all emphasis areas).

After a mechanical thin, residual activity fuels and some naturally occurring fuels are piled by a grapple piler into burn piles. A grapple piler is typically an excavator that can pick up fuels from the ground surface, carry the material suspended from the ground, and place it in a pile for burning. This equipment would operate on slopes generally less than 25 percent. Short pitches less than 150 feet long and up to 30 percent in slope would also be included in treatments using ground based equipment. Grapple piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger.

Mastication

Units: 87 (all emphasis areas), 46 - emphasis areas 5, 6, and 7, 76 - emphasis areas 5, 6, and 7, 85 - emphasis areas 5 and 6, 99 - emphasis areas 5 and 6.

As stated above, a masticator is a low ground pressure piece of equipment that “chews” up brush, small understory trees and downed woody fuels. Mastication does not actually remove wildland fuels from the treated area, but changes the size, continuity, and arrangement of the fuels, leading to an acceleration of decomposition rates of processed material and producing a desired change in fire behavior. Mastication changes a vertical large piece of fuel (i.e. a standing tree) into many smaller pieces of horizontal fuel. This is termed “rearranging” the fuels to a condition that allows the material to decompose more rapidly and/or burn more quickly with less intensity (small pieces). It would also be more difficult to ignite this material (horizontal, on the ground with less air flow). Mastication can be a mechanized method of implementing a lop and scatter fire/fuels prescription. This equipment would operate on slopes generally less than 25 percent. Short pitches less than 150 feet long and up to 30 percent in slope would also be included in treatments using ground based equipment. Mastication is also a Silvicultural Treatment Method – see above.

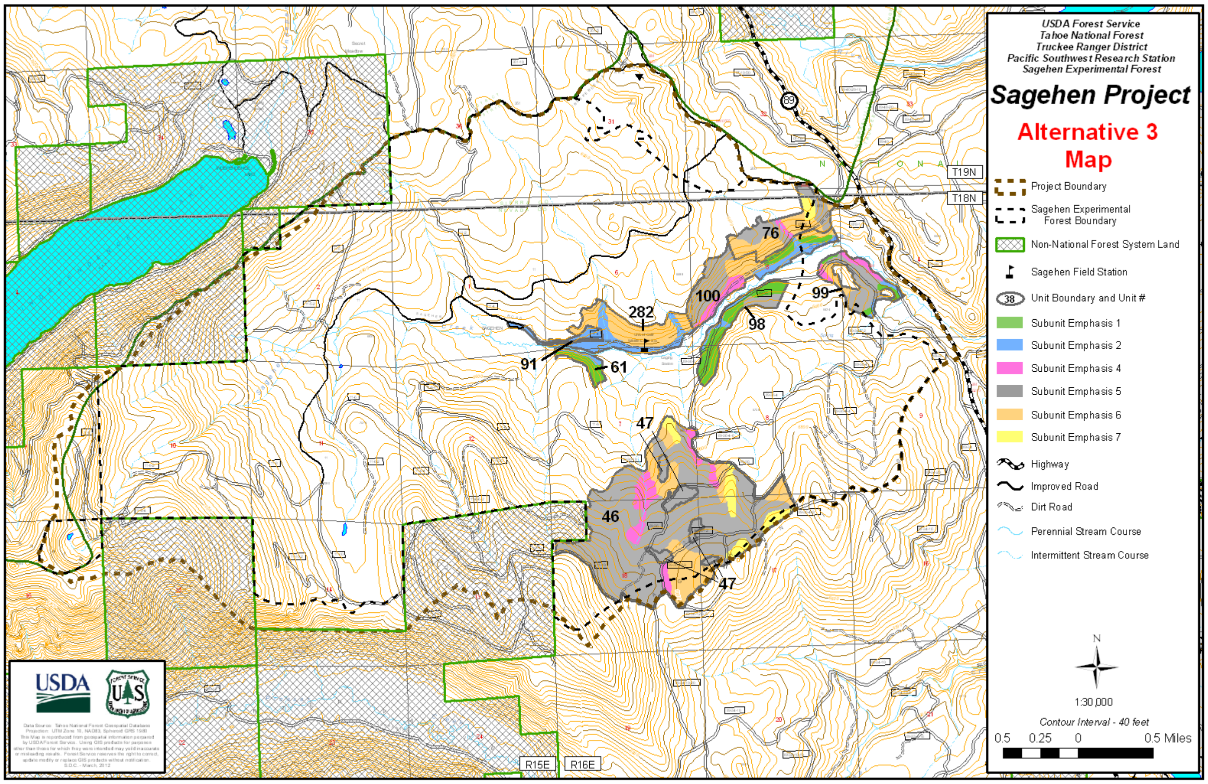
ALTERNATIVE 2 (NO ACTION)

Under the No Action Alternative, none of the activities proposed under Alternative 1 or Alternative 3 would be implemented. The No Action Alternative would not preclude activities that have already been approved in this area or those being planned as separate projects.

ALTERNATIVE 3 (NON-COMMERCIAL FUNDING)

Alternative 3 was developed in accordance with Eastern District Court Judge England's November 4, 2009 order for Case 2:05-cv-00205-MCE-GGH. The order requires the Forest Service to analyze a non-commercial funding alternative in detail for all new fuel reduction projects not already evaluated and approved as of November 4, 2009. To develop this alternative, the proposed treatment areas were revisited to determine (a) if a beneficial fuel treatment was possible and (b) what those treatments would be.

Map 2: Alternative 3 Map



A total of 1,132 acres were considered for non-commercial treatments. All units were not considered to be treated under this alternative because the cost would have been too great. Therefore, in order to reduce implementation costs to around one million dollars, the most critical units were chosen for treatment (including fuels only prescriptions on all units would have cost close to twice that amount). The treatments identified only partially meet the purpose and need by addressing hazardous surface and ladder fuels. The following actions are proposed under Alternative 3 (Table 4) and are displayed on Map 2. Note that while emphasis areas are displayed here, there are no project goals specifically tied to each emphasis area in Alternative 3 like there are in Alternative 1. The emphasis areas are displayed solely to provide a consistent way to compare the alternatives.

Table 4: Summary of Alternative 3 by Treatment Area

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Silvicultural Rx – *see Order of Prescription Application section above*	Silvicultural Treatment Method	Fire/Fuels Rx	Fire/Fuels Treatment Method
33	118	1	4	No Treatment	N/A	No Treatment	N/A
		4	30				
		5	28				
		6	56				
34	68	5	16	No Treatment	N/A	No Treatment	N/A
		6	47				
		7	5				
35	64	1	8	No Treatment	N/A	No Treatment	N/A
		4	6				
		5	7				
		6	37				
		7	6				
36	101	4	18	No Treatment	N/A	No Treatment	N/A
		5	13				
		6	56				
		7	14				
38	210	1	67	No Treatment	N/A	No Treatment	N/A
		4	7				
		5	86				
		7	50				
39	32	5	32	No Treatment	N/A	No Treatment	N/A
46	621	4	47	No Treatment	N/A	Surface Fire Rx	Underburn
		5	431	Plantation Thin	Mechanical Mastication	Lop & Scatter Surface Fire Rx	Mastication Underburn
		6	105				
		7	38				
47	33	5	33	No Treatment	N/A	Surface Fire Rx	Underburn
61	20	1	15	Suppressed Cut	Hand Thinning	Pile Burn Rx Surface Fire Rx	Hand Pile Pile Burn Underburn
		2	5				
73	144	4	6	No Treatment	N/A	No Treatment	N/A
		5	107				
		6	27				
		7	4				
76	91	4	4	No Treatment	N/A	Surface Fire Rx	Underburn
		5	37	Plantation Thin	Mechanical Mastication	Lop & Scatter Surface Fire Rx	Mastication Underburn
		6	42				
		7	8				
80	5	8	5	No Treatment	N/A	No Treatment	N/A
85	64	5	10	No Treatment	N/A	No Treatment	N/A
		6	53				
		8	1	No Treatment	N/A	No Treatment	N/A
87	207	5	67	No Treatment	N/A	No Treatment	N/A

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Silvicultural Rx – *see Order of Prescription Application section above*	Silvicultural Treatment Method	Fire/Fuels Rx	Fire/Fuels Treatment Method
		6	130				
		7	10				
89	34	4	6	No Treatment	N/A	No Treatment	N/A
		6	28				
90	40	6	40	No Treatment	N/A	No Treatment	N/A
91	9	2	9	Suppressed Cut	Hand Thinning	Pile Burn Rx	Hand Pile Pile Burn
98	63	1	43	Suppressed Cut	Hand Thinning	Pile Burn Rx	Hand Pile Pile Burn
		2	9				
		5	11				
99	67	1	7	Suppressed Cut	Hand Thinning	Pile Burn Rx	Hand Pile Pile Burn
		2	4				
		4	11				
		5	37	Plantation Thin	Mechanical Mastication	Lop & Scatter	Mastication
		6	8				
100	120	1	14	Suppressed Cut	Hand Thinning	Pile Burn Rx Surface Fire Rx	Hand Pile Pile Burn Underburn
		2	19				
		4	17				
		5	46				
		6	24				
156	84	1	84	No Treatment	N/A	No Treatment	N/A
163	82	1	29	No Treatment	N/A	No Treatment	N/A
		5	49				
		7	4				
213	268	1	182	No Treatment	N/A	No Treatment	N/A
		2	11				
		4	21				
		5	18				
		6	25				
		7	11				
282	108	2	46	Suppressed Cut	Hand Thinning	Pile Burn Rx Surface Fire Rx	Hand Pile Pile Burn Underburn
		6	62				

Prescription and Treatment Method Definitions (associated treatment areas):

Silvicultural Prescriptions

Suppressed Cut

Units: 61, 91, 98, 100, 282 (all emphasis areas), 99 - emphasis areas 1, 2, and 4.

A suppressed tree is typically no larger than ten inches dbh (usually ranging between one and five inches dbh) *and* is a component of a stand’s understory, where there is an overstory of dominant, codominant, and subdominant trees. Suppressed trees, in general, have little capacity to release (initiate increased growth rates), even if the overstory is removed. These trees often make up the lower levels of ladder fuels, and the suppressed tree layer combined with subdominant trees helps connect the forest floor into the crowns of dominant/codominant trees, which can increase fire severity and the potential for crown fire.

The suppressed cut would remove suppressed trees (down to one inch dbh for hand thinning and down to three inches dbh for mechanical thinning). Suppressed tree removal would facilitate use of prescribed fire while helping to minimize the risks of crown fire by removing some ladder fuels.

Although the suppressed cut prescription is proposed to remove the majority of trees less than ten inches dbh in the units proposed for treatment, the limited treatment in emphasis area 4 of the plantation thinning prescription (see below) and the remainder of the units not proposed for treatment will more than meet Forest Plan requirements of retaining at least five percent of trees between six and 24 inches dbh within the overall project area.

Plantation Thinning

Units: 46- emphasis areas 5, 6, and 7, 76- emphasis areas 5, 6, and 7, and 99- emphasis areas 5 and 6.

Plantations in the Sagehen Project Area were established in the 1960s and 1970s following the Independence and Donner Ridge wildfires. The plantations are largely comprised of planted Jeffrey and ponderosa pines; however, they also contain young trees that grew in naturally. The plantation thinning prescription is designed to facilitate and accelerate the continued growth of these young trees. The plantations currently contain some trees that survived wildfire and subsequent salvage harvest: these “residual” trees would not be removed. While they do meet the definition of legacy trees, residual trees in plantations would be treated differently than individual or small groups of legacy trees with a focus on removing ladder fuels to protect them during prescribed burning treatments. There also would be an emphasis on removing ladder fuels on the downhill sides of the residual trees where steep slopes may contribute to flame lengths reaching the residual trees.

Plantation thinning would involve mechanical thinning and/or mastication (mechanical grinding and crushing that *rearranges* material on site) of plantation trees and mastication of brush. Mastication changes a vertical large piece of fuel (i.e. a standing tree) into many smaller pieces of horizontal fuel. This is termed “*rearranging”* the fuels to a condition that allows the material to decompose more rapidly. The plantation thinning prescription would primarily focus on removing and/or rearranging trees between one and 12 inches dbh. An occasional tree between 12 and 18 inches dbh could be removed; however, this would occur only where mechanical cutting and removal systems were used. The majority of trees between 12 and 18 inches dbh would be retained. Because of the nature of plantations and the logistics of marking trees in extremely dense brush, trees would be thinned by description and a spacing guideline would be applied. Typically, retained trees would be spaced roughly 14 to 22 feet apart. Plantation thinning would retain at least 120 trees per acre. Sufficient tree canopy cover would be maintained to suppress shrub growth under groups of trees; however, retarding shrub growth over the entire treatment unit would not be a specific objective.

Shrubs growing under the drip line of retained trees would be masticated. Other areas of snow brush, manzanita, and white thorn outside the drip lines would also be masticated to decrease the fire hazard and provide opportunities for brush regeneration. Further, patches of bitterbrush and *Ribes* outside of tree drip lines would not be masticated unless they posed a fire hazard (ladder fuels) to retained trees/groups of trees. Bitterbrush is a preferred browse species for mule deer and it occurs in some homogeneous small patches in the plantations. These patches provide valuable foraging habitat. Because bitterbrush and *Ribes* do not regenerate (stump sprout) very well after mastication, unless posing a direct ladder fuels hazard, these species would not be masticated.

In addition to spacing guideline ranges, other measures would be implemented to increase within-stand horizontal heterogeneity. Where less than ten trees per acre are present, no trees would be thinned and shrubs would not be masticated; however, these areas could be underburned. Because the plantations are largely composed of Jeffrey and ponderosa pines, species preference for retention would focus on other species, if they are present. This could mean that a larger pine would be proposed for removal/mastication if it is in close proximity to a tree of another species, such as red fir.

Identified drainage bottoms within plantations would not be treated. Based on existing conditions in the plantation treatment units, it is estimated that at least ten percent of the overall plantation acreage would be included in these residual tree zones, sparsely treed areas, and drainages. These areas would enhance heterogeneity in the treated plantations.

Silvicultural Treatment Methods

Mechanical Thinning

Units: 46- emphasis areas 5, 6, 7, 76- emphasis areas 5, 6, and 7, 99- emphasis areas 5 and 6.

Mechanical thinning is a harvest activity, which, under the Sagehen Project would utilize ground-based equipment (tractors, feller bunchers and some chainsaw work) to fell and remove identified trees while retaining and protecting desirable trees to accomplish fuels reduction objectives. A network of skid trails (in the case of ground-based thinning operations), landings, and, in some cases, temporary roads (which are removed following project activities) would be used to transport and collect harvested material. This equipment would operate on slopes generally less than 25 percent. Short pitches less than 150 feet long and up to 30 percent in slope would also be included in treatments using ground based equipment. A borate compound would be applied to all white fir stumps greater than 14 inches in diameter to prevent Annosus root disease.

Hand Thinning

Units: 61, 91, 98, 100, 282 (all emphasis areas), 99 - emphasis areas 1, 2, and 4.

Hand thinning is an activity that utilizes crews with chainsaws or handsaws that cut understory conifers less than 16 inches dbh to accomplish fuels reduction objectives. If hand felled material contributes to unacceptable fuel loading, this material may be hand piled outside the drip lines of desirable trees and burned when conditions permit a minimum amount of mortality.

Mastication

Units: 46 - emphasis areas 5, 6, and 7, 76- emphasis areas 5, 6, and 7, 99- emphasis areas 5 and 6.

A masticator is a low ground pressure piece of equipment that "chews" up brush and small understory trees to reduce competition. The machine mechanically grinds and crushes this material and down woody fuels and distributes the resulting small pieces around the site. This equipment would operate on slopes generally less than 25 percent. Short pitches less than 150 feet long and up to 30 percent in slope would also be included in treatments using ground based equipment. Mastication is also a Fire/Fuels Treatment Method – see below.

Fire/Fuels Prescriptions

Surface Fire Prescription

Units: 46, 47, 61, 76, 100, 282 (all emphasis areas).

A surface fire is a fire that burns live and dead fuels at or near the surface of the ground, mostly by flaming combustion. A surface fire prescription is usually implemented by an underburn. Surface fire prescriptions are typically designed to consume surface and ladder fuels and to mimic fire that would occur in an active fire regime. Surface fire prescriptions can be applied under spring-like and fall-like conditions. Spring-like conditions are defined by relatively high live fuel moistures, high 1000 hour size ("coarse woody debris", three inches diameter and greater) fuel moistures, and soils that are relatively moist beneath the surface fuels. Under spring-like conditions, it is expected that surface fires would have moderate to high consumption of 1-100 hour size fuels ("fine woody debris", ranging from 0.00-2.99 inches diameter) and minimal consumption of 1000+ hour fuels with mortality primarily expected in subdominant tree size classes. Fall-like conditions are defined by relatively low live fuel moistures, lower 1000 hour fuel moistures, and drier soils with dry organic layers beneath the litter layer. Under fall-like conditions, it is expected that burning would be primarily surface fires with higher flame lengths, and faster burn times as compared to burning under spring-like conditions. It would have high consumption of 1-100 hour size fuels and moderate to high consumption of 1000+ hour fuels, and with mortality expected in subdominant and some codominant tree size classes. Depending on cycles of drought and wet weather, spring-like and fall-like conditions can occur throughout the year. For the Sagehen Project, spring-like condition surface fire prescriptions would be emphasized, however due to limited suitable burning conditions, surface fire prescriptions under fall-like conditions would be implemented in some cases.

Pile Burn Prescription

Units: 61, 91, 98, 100, 282 (all emphasis areas), 99 - emphasis areas 1, 2, and 4.

A pile burn prescription is designed to remove surface fuels, both fuels generated from silvicultural treatments (activity fuels) and existing fuels on the ground. A pile burn prescription can be implemented by hand or by machinery. In general, small down wood is placed in piles for future burning. Pile location and size is dictated by existing conditions, however piles would be preferentially placed outside of sensitive areas such as riparian conservation areas and cultural resource sites. Piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger. This prescription removes surface fuels in the treatment units and is used to mimic underburning where sensitive areas prevent unit-wide application of underburning.

Lop and Scatter

Units: 46 - emphasis areas 5, 6, and 7, 76 - emphasis areas 5, 6, and 7, 99 - emphasis areas 5 and 6.

A lop and scatter prescription does not remove fuels from treated areas. It prescribes changing the size and arrangement of the fuels. Lop and scatter prescriptions usually deal with activity generated fuels as a result of tree removal (tree tops and branches), however it can also apply to brush and standing ladder fuels. The purpose of a lop and scatter prescription, by changing the arrangement and size of fuels, is to take the fuels to a condition that allows the material to break down more rapidly.

Fire/Fuels Treatment Methods

Underburning

Units: 46, 47, 61, 76, 100, 282 (all emphasis areas).

Underburning is a generalized term used when applying prescribed fire to large areas and is typically the treatment method for a surface fire prescription. Underburning targets surface fuels, some understory, and, in rare cases, larger trees. Surface fuels are the primary agent of fire spread. The objective is to apply controlled fire under optimum conditions where the treatment can modify fuel conditions to effectively reduce fire behavior and the corresponding intensity of a future wildfire. Within some areas proposed for burning, the goal of the treatment may be to consume a significant portion of the existing surface fuels that could cause high wildfire intensities, and/or the consume understory vegetation (ladder fuels) in order to reduce future fire severity and to create conditions that allow for future prescribed underburning opportunities. In other areas, underburning is used to create new growth of native shrub species and forage opportunities for wildlife. Underburning most closely mimics low-intensity fire that would occur in an active fire regime. Underburning, especially on south and west facing slopes, is typically conducted under spring-like conditions. A more mosaic burn pattern is created by underburning in spring-like conditions as compared to fall-like conditions; with some areas minimally burned and overall less fuel consumption. For the Sagehen Project proposal, underburning would be applied on a unit-wide basis, in other words, where underburning is proposed it would be conducted across the entire treatment unit and across all subunits (emphasis areas) within that treatment unit.

Hand Piling and Burning

Units: 61, 91, 98, 100, 282 (all emphasis areas), 99 - emphasis areas 1, 2, and 4.

After a hand or mechanical thin, residual activity fuels and some naturally occurring fuels are piled by hand into burn piles. Hand piles of fuels typically are burned under fall-like conditions, in winter months, or during periods of low fire danger.

Mastication

Units: 46 - emphasis areas 5, 6, and 7, 76 - emphasis areas 5, 6, and 7, 99 - emphasis areas 5 and 6.

As stated above, a masticator is a low ground pressure piece of equipment that “chews” up brush, small understory trees and downed woody fuels. Mastication does not actually remove wildland fuels from the treated area, but changes the size, continuity, and arrangement of the fuels, leading to an acceleration of decomposition rates of processed material and producing a desired change in fire behavior. Mastication changes a vertical large piece of fuel (i.e. a standing tree) into many smaller pieces of horizontal fuel. This is termed “rearranging” the fuels to a condition that allows the material to decompose more rapidly. Mastication can be a mechanized method of implementing a lop and scatter fire/fuels prescription. This equipment would operate on slopes generally less than 25 percent. Short pitches less than 150 feet long and up to 30 percent in slope would also be included in treatments using ground based equipment. Mastication is also a Silvicultural Treatment Method – see above.

IV. ENVIRONMENTAL CONSEQUENCES

A. INDICATORS USED TO ANALYZE IMPACTS ON FOREST STANDS

The following indicators are used to assess the impacts of the proposed action and other alternatives on forest stand conditions in the Sagehen Project Area: stand density, medium and large trees, tree mortality, canopy cover and variability. The sections below discuss each of these indicators in detail and explain why each was selected for this analysis.

Stand Density

A number of parameters are available to serve as metrics for stand density, among them basal area, volume, and stand density index. Basal area (defined by the area occupied by the cross-section of tree stems at a person’s breast height (4.5 feet)) was selected for this analysis.

Basal area has proven to be a useful metric for many forest elements. It is cited regularly in the scientific literature and its uses range from establishing wildlife species habitat requirements, to evaluating transpiration rates across ecosystems, to understanding density stresses within forest stands. The Sagehen Project objectives warranted the use of this metric for several reasons. First, basal area can be readily measured and applied in the field. Secondly, Forest Plan direction for mechanical thinning treatments in mature forest habitat includes a basal area retention standard. Finally, basal area served as an easily understood metric during the collaborative process used to develop the Sagehen Project proposed action. Generally, higher amounts of basal equal more dense conditions, which can lead to decreased growth rates and an increase in density induced stresses. Ultimately, these stresses are exacerbated if the majority of the stand’s basal area is in smaller trees. In other words, two stands could have the same basal area, but the stand with more, smaller trees would have lower growth rates and a higher incidence of density induced stresses than the stand with fewer, larger trees. It is therefore important to understand which tree size classes comprise the majority of a stand’s basal area.
Basal area and the percent of basal area in trees greater than 19.9 inches dbh is used in this analysis to compare treatment effects on stand density.

Medium and Large Trees

As discussed in the GTR-220, "large" trees vary with forest type and site productivity, and there is no set size at which a tree takes on the positive ecosystem attributes of a larger living structure (North et al. 2009). For purposes of this analysis, the medium and large tree indicator is represented by trees greater than 19.9 inches dbh. Trees greater than 19.9 inches dbh are generally underrepresented in the Sagehen Project Area due to historic logging and stand replacing fires. Their presence ensures a unique, natural and historic seed source remains on the landscape while adding vertical and horizontal structure to an otherwise relatively younger forest. Trees of this size are generally more resilient to disturbance because of their relatively thicker bark and elevated crown base heights, which can mitigate fire effects and repel beetle attack. In general, a stand that developed under active fire conditions in the Sagehen Basin would have been expected to have the majority of its basal area in larger trees.

Tree Mortality

An important issue for forest management is how to assess and predict amounts of tree mortality associated with stand densities in different environments, and amounts of tree mortality that are either desirable or undesirable in terms of forest structure. The likelihood of disturbances becoming stand replacing increases in probability as stand density and the degree of homogeneous conditions increases. Yet, precipitous drops in tree populations as a result of stand replacing disturbances are hard to predict. Therefore, this report will focus on how density directly affects mortality while qualitatively discussing how size and intensity of treatments affect probabilities of stand replacing disturbances.

Canopy Cover

Canopy cover is an indicator that is significant, silviculturally, when analyzed as a signature of tree growth potential as well as the probability of shade intolerant versus tolerant tree species regeneration. However, since Sagehen Project goals are more focused on structure and resiliency over growth, its importance as a silvicultural indicator is lessened. Canopy cover, however, remains important in measuring the effect of treatments on other resources, such as fire behavior and wildlife habitat, and therefore will be utilized as an indicator in this report. Canopy cover is defined as the percentage of forest floor covered by the vertical projection of the tree crowns (Jennings et al. 1999 *in* North 2012). Cover is always measured vertically. It is a stand-level measure of canopy porosity (i.e. how much rain falls directly on the forest floor). As such, it is useful as a stand-level measure of how much of the forest floor is vertically overtopped with canopy. Canopy cover is typically either measured directly with a densiometer (sighting tube) or indirectly estimated using forest inventory plot data in the Forest Vegetation Simulator (FVS) (North 2012). Further, the Forest Plan requires mechanical thinning treatments retain at least 40 percent canopy cover at the treatment unit scale in mature forest habitat (stands classified as California Wildlife Habitat Relationship (CWHR) types 4M, 4D, 5M, 5D, and 6), and 50 percent canopy cover in these CWHR types within California spotted owl Home Range Core Areas.

Variability

It has long been understood that forests are highly variable at many scales, but only recently has science been able to assess levels of variability at various scales relative to important ecosystem processes. As the GTR 220 explains, "In the Sierra Nevada, historical data (Bouldin 1999, Lieberg 1902), narratives (Muir 1911), and reconstruction studies (Barbour et al. 2002, Bonnicksen and Stone 1982, Minnich et al.

1995, North et al. 2007, Taylor 2004) indicate mixed conifer forests were highly clustered with groups of trees separated by sparsely treed or open gap conditions. This clustering can be important for regenerating shade-intolerant pine (Gray et al. 2005, North et al. 2004, York and Battles 2008, York et al. 2003)…Studies in Baja's Sierra San Pedro del Martir (SSPM) forests also indicate forest structures (live, trees, snags, logs and regeneration) are highly clustered (Stephens 2004, Stephens and Fry 2005, Stephens and gill 2005, Stephens et al. 2007a). This forest in Mexico shares many characteristics of mixed-conifer forests found in Sierra Nevada but has had little fire suppression and has not been harvested. Although these Baja forests have a different weather pattern than California's Sierra Nevada (Evett et al. 2007), they can provide some insight into the structure and ecological dynamics of a mixed-conifer forest with an active fire regime. A recent study of stressed SSPM Jeffrey pine/mixed-conifer forests where a 2003 wildfire was preceded by a 4-year drought, found spatial heterogeneity was a key feature in forest resiliency (Stephens et al. 2008)" (North et al. 2009).

Managed variability refers to the approach of designing silvicultural prescriptions to enhance heterogeneity at multiple spatial scales (site, stand, and landscape scales). The Sagehen Project silvicultural prescriptions (specifically dense cover areas, early seral openings, variable thinning, and legacy tree treatments) are applied at varying intensities, based on differences in slope position, slope aspect, and slope steepness, with the Project's emphasis areas providing the template for this variation. Carefully managing variability in this way is aimed at developing forest conditions expected under an active fire regime with active fire conditions.

Forest managers are increasingly exploring the tools and developing the skills to implement and monitor this complex variability at multiple scales. A relatively straightforward way to quantify variability is to calculate the coefficient of variation (CV) for selected stand metrics (for example, basal area, canopy cover, and mortality) before treatment implementation and then predict the post-treatment CV for these stand metrics through modeling or field measurements. "By dividing a population's standard deviation by its mean, the coefficient of variation permits a comparison of relative variability about different-sized means. In effect, CV, often expressed as a percentage, standardizes variability around the mean of the sample population" (North 2012). In other words, the absolute value of CV ultimately depends on the sampling scale, but an increase in CV from the same sample set following treatment is expressing an increase in variability. The greater the CV change, the greater the amount of expected variability. In order to show the relative changes in managed variability at different scales, this analysis assesses changes in variability before and at specific points in time after implementation of each alternative at the site, stand, and landscape scales.

While enhancing variability at the landscape scale is an important goal (linked to the emphasis areas' stand level ecological restoration objectives), equally important is achieving increased landscape variability through careful management that could mimic where some of that variability might have existed under active fire conditions. As discussed in the emphasis area creation section, topographical areas were assembled into emphasis areas based on goals. The emphasis areas were then lineally organized as one moves from emphasis area 1 to emphasis area 7 by a gradual decrease in how much basal area an emphasis area would support if influenced by active fire. (Since basal area changes directly affect selected stand metrics (canopy cover and mortality), changes between emphasis areas for these metrics should follow similar patterns as changes in basal area.) Therefore, under active fire conditions, one would expect to see a gradual ramping of basal area, canopy cover, and mortality values between numerically adjacent emphasis areas (for example, but not limited to, between emphasis area 1 as compared to 2, emphasis area 2 as compared to 4, or emphasis area 6 as compared to 7). Abrupt or large differences in values for these indicators between adjacent emphasis areas would indicate less resemblance to stand conditions in the Project Area units had they developed under active fire conditions. To assess the potential for these large or abrupt differences in forest stand conditions, linear regressions for selected forest stand metrics (including immediate post-treatment basal area and canopy cover and 30-year projected mortality) by emphasis area under each alternative are compared using the coefficient of determination, referred to as R^2.

B. METHODOLOGY AND ASSUMPTIONS

Several datasets are available to assess existing conditions in the Sagehen Project Area, including:

- stand examination data collected in the natural stands proposed for mechanical thinning treatments, using common stand exam protocol, during the summer of 2003;
- remotely sensed vegetation data;
- forest inventory data collected from more than 500 permanent vegetation plots by UC Berkeley researchers in 2006; and
- basal area plots measured within emphasis areas that were lacking representative information from the above datasets.

All four of these datasets were used to inform deliberations during collaborative development of the proposed action, particularly to establish objectives for post-treatment residual basal area within each unit's emphasis areas. However, this analysis relies primarily on the UC Berkeley forest inventory data to characterize existing conditions, past treatment and model 30-year projections for the silvicultural indicators. The UC Berkeley dataset was selected for analysis because it is the most robust and comprehensive data available on existing forest stand conditions in the Sagehen Project Area. In addition, the location of each permanent plot is mapped, ensuring accurate assignment of data to each treatment unit.

Valiant (2008) provides the following description regarding the design of the UC Berkeley vegetation plots in the Sagehen Basin:

> *Plot Selection*
>
> *A systematic grid of 522 permanent, georeferenced 0.05 ha circular plots was installed, based on a random starting point within Sagehen. The grid consists of three different densities, 500 m, 250 m, and 125 m spacing (Figure 2). The entire watershed is sampled by plots spaced on a 500 m interval. Areas not occupied by Jeffrey pine plantations were sampled at 250 m spacing. The 125 m spacing was used in 10 unique forest types to conduct high density sampling. At each plot, plot center and elevation were recorded using a hand held global positioning system (GPS) unit. In addition, aspect and slope were noted using a compass and clinometer.*

Vegetation Measurements

Tree measurements (species, diameter at breast height (DBH), height, canopy base height and tree crown position (dominant, codominant, intermediate or suppressed)) were recorded for all live trees greater than 5 cm DBH. Overstory trees (19.5 cm DBH) were tagged and measured in the whole plot (0.05 ha); pole-sized trees (5 cm DBH to <19.5 cm DBH) were measured in a randomly selected third of the plot (0.017 ha). Saplings, trees <5 cm DBH, were tallied by species and diameter class (1 cm increments) along a two meter belt encompassing three 12.62 m transects (0.0072 ha). In addition, snags greater than 5 cm DBH had species, DBH and height recorded. Canopy cover (CC) was measured at 25 points in a five-by-five grid with five meter spacing using a canopy sight tube (Gill et al. 2000) in all the plots for the 125 m spaced grid and any plots initiated after these were installed (113 plots).

The UC Berkeley data provides statistically valid data at the treatment unit scale; variability between emphasis areas is introduced via application of the silvicultural and fuels prescriptions. For this reason, existing conditions are reported at the treatment unit scale while immediate post-treatment and 30-year projections are assessed at the emphasis area (within treatment unit) scale.

Existing Conditions

Forest inventory data collected from more than 500 permanent vegetation plots by UC Berkeley researchers in 2006 provided the basis for quantifying existing conditions in the proposed treatment units. The Forest Vegetation Simulator (FVS) model (South Central Oregon Northern California variant) was used to “grow” the inventory data forward to represent conditions in 2011.

Post-Treatment Conditions

Several data sources were used to assess post-treatment stand conditions following application of the proposed silviculture and fuels prescriptions: (1) basal area plots measured during tree marking, (2) pre- and post-treatment data gathered in two 3-acre test plots, and (3) Forest Vegetation Simulator (FVS) modeling outputs.

Post-thinning basal area data were gathered from over 850 sample plots. These plots were measured in the treatment units proposed for mechanical thinning while the trees proposed to be removed were being marked. Not only did this ensure that basal area targets were being met within each emphasis area as the marking progressed, it also provided accurate immediate post-treatment basal area values for each emphasis area within each mechanically thinned treatment unit.

To assess the effects of this Project’s unique silviculture and fuels prescriptions on forest stand structure, two test plots, approximately three acres each, were established at two different elevations and aspects in the Sagehen Project Area. One test plot was located in the northeast portion of the Project Area (below 7,000 feet) while the other was located in the southwest portion (above 7,000 feet). The test plots were designed to be representative of different natural stand conditions found throughout the larger Project Area. Ten sample plots were measured within each test plot prior to tree marking. The two test plots were then marked according to the prescriptions previously described under “Alternatives Analyzed in Detail,” harvested, and in the case of one plot, underburned during the summer/fall 2010. Following implementation of these treatments, the test plots were re-inventoried to provide metrics of sizes, species, and numbers of trees removed, basal area removed and retained, and before and after canopy cover. Post-treatment photo point monitoring was also conducted. The plots helped to illustrate and test the effects of the proposed silviculture and fuels prescriptions and treatment methods. Specifically, the plots demonstrated the effects of variable thinning, legacy tree treatment, suppressed cut, dense cover area (DCA), and early seral opening (ESO) prescriptions on forest stand structure and tree species composition.

The Forest Vegetation Simulator (FVS) (Dixon 2003) was used to model conditions after application of the silviculture and fuels prescriptions proposed under each alternative. The FVS model's South Central Oregon Northern California variant was used for all simulations. Immediate post-treatment stand conditions were entered into FVS as a starting point for the simulations.

Due to the inherent difficulties of modeling some of the variability It is important to note, however, that the DCA

Projected Conditions

The Forest Vegetation Simulator (FVS) (Dixon 2003) was used to model conditions at 30 years after application of the silviculture and fuels prescriptions proposed under each alternative. The FVS model's South Central Oregon Northern California variant was used for all simulations. Immediate post-treatment stand conditions (based on the post-treatment information described in the preceding section) were entered into FVS as a starting point for the simulations.

The modeled results from FVS are not intended to be absolute values, but rather they display relative trends in stand development for the emphasis areas within each treatment unit. It is important to note that, while the model is an abstraction of reality and does not provide an exact representation of on-the-ground conditions, it is a useful tool for making comparisons between the alternatives.

Finally, FVS projections for all of the indicators in plantation units 46, 47, and 87 and, to some extent, natural young forest units 76, 98 and 99, may show a sizeable predicted change. This is primarily due to the dense, young, and uniform nature of these stands, where treatments, or lack thereof, can have a dramatic effect on how trees react, even after a relatively short amount of time. Since none of these plantation units are classified as mature forest habitat (CWHR type 4M, 4D, 5M, 5D and 6) nor are they located within California spotted owl or northern goshawk Protected Activity Centers (PACs) or California Spotted Owl Home Range Core Areas (HRCAs), mechanical thinning treatments are not required to meet the canopy cover or basal area retention standards for mature forest habitat described in the Forest Plan.

Stand Density

The metric for describing stand density is basal area, expressed in square feet per acre. The analysis presents existing basal area at the treatment unit scale and post-treatment basal area for each emphasis area within each treatment unit. Basal area is also used to assess medium and large tree densities, as described in the "Medium and Large Tree" section below.

Neither Dense Cover Area (DCA) nor Early Seral Opening (ESO) acres were used in calculating treatment effects on stand density (as measured by basal area and basal area in trees greater than 19.9 inches dbh), primarily because these prescriptions were driven by project objectives unrelated to stand density. These prescriptions are beneficial to forest systems at stand scales by introducing variability; however, because they occupy such small scales, the FVS model does not provide a means for quantifying their effects on a per acre basis across an emphasis area. With that said, DCA and ESO treatments are prescribed in similar amounts across most units, so either treatment effect, averaged across the unit, would likely be neutralized by the other.

Existing Condition. As previously described, forest inventory data collected from more than 500 permanent vegetation plots by UC Berkeley researchers in 2006 provided the basis for quantifying existing basal area conditions in the proposed treatment units. The Forest Vegetation Simulator (FVS) model (South Central Oregon Northern California variant) was used to "grow" the inventory data forward to represent conditions in 2011.

Post-Treatment Condition. Immediate post-thinning basal area plot data, gathered from the over 850 sample plots measured in the mechanical thinning units while trees were being marked, provided accurate estimates of post-thinning basal area for each emphasis area. To account for the potential effects of follow-up fuels treatments, the basal area marking targets were increased (approximately 10 square feet per acre) in units where underburning was prescribed. No other adjustments were made for other fuel treatments because their effect on basal area is negligible.

Plantations would not be marked, but instead trees slated for removal would be described in the contract for implementing the plantation thinning treatments. Post-treatment basal area estimates for plantations are based on an assumed 20-foot spacing guideline. (In actual practice, residual spacing would be more variable (14- to 22-foot spacing), as described in the proposed action.) In these areas, appropriate trees were removed and retained in FVS that met prescribed spacing requirements and tree retention specifications which generated post-treatment BA conditions.

Non mechanical thinning units would not be marked, but instead trees slated for cutting would be described in the contract or to force account crews implementing the silviculture and fuels treatments. In these areas, appropriate trees were removed and retained in FVS that met prescribed tree removal and retention specifications which generated post-treatment BA conditions.

Projected Condition. For the action alternatives (Alternatives 1 and 3), post-treatment residual basal area values (described above) were used to modify the existing condition tree lists in FVS for both natural stands and plantations to account for the immediate effects of the proposed treatments. These modified tree lists (which represented immediate post-treatment conditions) were then grown forward 30 years using the FVS model to arrive at projected basal area conditions. For the No Action Alternative (Alternative 2), the existing condition tree lists (with no modifications due to treatment effects) were grown forward 30 years using the FVS model.

Medium and Large Trees

There are several metrics used to assess the medium and large tree indicator: (1) the proportion (percentage) of basal area in trees greater than 19.9 inches dbh, (2) the amount of trees removed in all size classes and (3) the amount of trees remaining in the treatment units that are greater than 19.9 inches dbh.

Existing Condition. As previously described, forest inventory data collected from more than 500 permanent vegetation plots by UC Berkeley researchers in 2006 provided the basis for quantifying existing basal area in trees greater than 19.9 inches dbh in the proposed treatment units. The Forest Vegetation Simulator (FVS) model (South Central Oregon Northern California variant) was used to "grow" the inventory data forward to represent conditions in 2011.

Post-Treatment Condition. Timber cruise reports (3P and plot cruise) provided data on numbers and species of trees to be removed by size class within the mechanical thinning units only. The remaining treatment units have tree cutting; however, the trees prescribed to be felled would not exceed 15.9 inches dbh. Further, it was assumed that the follow-up fuels treatments (grapple piling, hand piling, pile burning, or underburning) would not measurably affect the proportion of basal area in medium and large trees. FVS model runs provided estimates the immediate post-treatment proportion of basal area in medium and large trees. In addition, actual post-treatment tree size data from the two test plots, as well as the timber cruise report data, validated the FVS-modeled immediate post-treatment estimates of numbers of medium and large trees.

Projected Condition. The FVS model was used to grow stands forward in time following the treatments to project the percentage of the basal area in trees greater than 19.9 inches dbh 30 years after all prescriptions were implemented within each emphasis area.

Tree Mortality

The analysis considers two mortality assessments, one that includes all mortality and another that includes mortality only in trees greater than 14.9 inches dbh. The first mortality metric, percent of all mortality, is calculated by dividing the amount of tree volume that dies in a given year by the total tree volume present in that year. The second mortality metric, percent of mortality in trees greater than 14.9 inches dbh, is calculated by dividing the amount of individual trees greater than 14.9 inches that die in a given year by the total amount of individual trees that die in that year.

As described in the previous sections, Dense Cover Area (DCA) and Early Seral Opening (ESO) acres were not included in the mortality calculations.

Existing Condition. As previously described, forest inventory data collected from more than 500 permanent vegetation plots by UC Berkeley researchers in 2006 provided the basis for quantifying existing mortality as a percentage of total tree volume in the proposed treatment units. The Forest Vegetation Simulator (FVS) model (South Central Oregon Northern California variant) was used to "grow" the inventory data forward to represent conditions in 2011.

Projected Condition. For the action alternatives (Alternatives 1 and 3), post-treatment residual basal area values (previously described under the Stand Density indicator) were used to modify the existing condition tree lists in FVS for both natural stands and plantations to account for the immediate effects of the proposed treatments. These modified tree lists (which represented immediate post-treatment conditions) were then grown forward 30 years using the FVS model to arrive at projected tree mortality percentages. For the no action alternative (Alternative 2), the existing condition tree lists (with no modifications due to treatment effects) were grown forward 30 years using the FVS model.

Canopy Cover

The metric for canopy cover is percentage of area occupied by tree crowns. As described in the previous sections, Dense Cover Area (DCA) and Early Seral Opening (ESO) acres were not included in the canopy cover calculations.

Note that field observations in the Sagehen Basin as well as research (Fiala et al. 2006) has shown that FVS canopy cover estimates are consistently lower and more variable than most field estimates. In order to quantify more accurate canopy cover estimates, test plot pre- and post-treatment measurements were made for canopy cover. Measurements confirmed that FVS was consistently overestimating canopy cover by approximately 10 percent. Hence, the FVS estimates of both pre- and post-treatment canopy cover have been adjusted upward by 10 percent.

Existing Condition. As previously described, forest inventory data collected from more than 600 permanent vegetation plots by UC Berkeley researchers in 2006 provided the basis for quantifying existing percentage of tree canopy cover in the proposed treatment units. The Forest Vegetation Simulator (FVS) model (South Central Oregon Northern California variant) was used to “grow” the inventory data forward to represent conditions in 2011.

Post-Treatment Condition. Of greatest interest is immediate post-treatment canopy cover as this would be the lowest level of canopy cover. Over time, canopy cover would increase as the treated stands developed. For the action alternatives (Alternatives 1 and 3), post-treatment residual basal area values (previously described under the Stand Density indicator) were used to modify the existing condition tree lists in FVS for both natural stands and plantations. FVS canopy cover estimates associated with these modified tree lists account for the immediate effects of the proposed treatments on residual canopy cover.

Variability

Variability is assessed at three scales: site, stand, and landscape. The metric for variability at the site scale is the coefficient of variation for pre- and post-treatment basal area and canopy cover. Percentage of treated area in early seral openings (ESOs) and dense cover areas (DCAs) is used as the metric for assessing variability at the stand scale. The metrics used for analyzing managed variability at the landscape scale are basal area, canopy cover, and mortality.

Site Scale: The site scale is usually represented by pockets of three to seven trees, and is rarely larger than a quarter of an acre. Pre- and post-treatment data from the two 3-acre test plots are used to estimate variability at this scale. The coefficients of variation for basal area and canopy cover before treatment are compared to the coefficients after implementation is complete. This test plot analysis provides estimates of CV change applicable to the mechanical thinning treatments. For the hand thinning units, it is assumed that, while hand treated areas would show some CV change, these changes would be less than those for areas treated using mechanical thinning. Because hand thinning treatments would be unable to remove trees greater than 15.9 inches dbh, CV changes for these areas would not be as high as the mechanical thinning units, even though the types of prescriptions are similar.

Stand Scale: The stand scale is determined by stands of trees. A stand of trees is typically defined by areas of similar species composition, ages, and health of trees. Average stand size is between 15 and 20 acres, and stands are comprised of many sites. Dense Cover Area (DCA) and Early Seral Opening (ESO) acres are used as the metric to assess variation at the stand scale.

Landscape Scale: For this analysis, the landscape scale is defined by the emphasis areas delineated for the Sagehen Project. Two statistical tools are used in assessing the effects of the alternatives in terms of managed variability at the landscape scale: (1) coefficient of variation (CV) and (2) linear regression and coefficient of determination (R^2) value. The CV was used to assess landscape-scale variability over time by comparing FVS projections for three metrics, basal area, canopy cover, and mortality, for each alternative. Linear regressions and their associated R^2 values were used to compare dramatic (i.e. large and/or abrupt) shifts (volatility) in stand conditions between emphasis areas based on basal area, canopy cover, and 30-year mortality projections.

Existing Conditions. As a starting point for both the CV and regression analyses, the UC Berkeley permanent vegetation plot data were stratified into the applicable emphasis areas. As previously described, the Forest Vegetation Simulator (FVS) model (South Central Oregon Northern California variant) was used to “grow” the inventory data for each emphasis area forward to represent conditions in 2011.

Post-Treatment Basal Area. As previously described for the Stand Density indicator, basal area plot data, gathered from the over 850 sample plots measured in the mechanical thinning units while trees were being marked, provided accurate estimates of immediate post-thinning basal area for each emphasis area. Post-treatment basal area estimates for plantations are based on an assumed spacing guideline and appropriately modified in FVS to generate post-treatment BA conditions. Post-treatment basal area estimates for non-mechanical thinning units were based on assumed effects of the silviculture and fuels prescriptions and appropriately modified in FVS to generate post-treatment BA conditions. For the action alternatives (Alternatives 1 and 3), these immediate post-treatment residual basal area values were used to modify the existing condition tree lists in FVS for both natural stands and plantations to account for the immediate effects of the proposed treatments.

Post-Treatment Canopy Cover. As previously described for the canopy cover indicator, post-treatment residual basal area values were used to modify the existing condition tree lists in FVS for both natural stands and plantations. FVS canopy cover estimates associated with these modified tree lists (combined with an additional 10 percent adjustment as previously described) account for the immediate effects of the proposed treatments on residual canopy cover.

Mortality Projections. Mortality modeled in FVS is directly related to stand density and competition between trees, with higher levels of stand density resulting in greater amounts of mortality. Immediate post-treatment mortality levels are not indicative of the stand's response to treatments; however, the mortality effects begin to show as the stand develops over time. Hence, 30-year mortality projections indicate forest stands' longer-term response to the actions proposed under each alternative. As discussed above, post-treatment residual basal area values were used to modify the existing condition tree lists in FVS, and these conditions were modeled over time to arrive at annual projected mortality up through 30 years in the future.

Coefficient of Variation

The coefficient of variation is reported as a percentage and calculated by dividing the standard deviation by the average and multiplying the result by 100. For example, a CV of 3 percent means the standard deviation is equal to 3 percent of the average. FVS modeling results were used to calculate the CV for basal area and canopy cover following treatment. FVS modeling results were also used to chart changes in the mortality CV between emphasis areas over time under each alternative.

Linear Regression and Coefficient of Determination

Simple linear regressions were developed to show differences in selected stand metrics (basal, canopy cover, and 30-year mortality projection) between the emphasis areas. With a simple linear regression, R^2 equals the square of the correlation coefficient between the observed and modeled (predicted) data values. R^2 is a statistic that provides information about the goodness of a model fit. In regression, the R^2 coefficient of determination is a statistical measure of how well the regression line approximates the real data points. An R^2 of 1.0 indicates that the regression line perfectly fits the data. Therefore the greater the values of the metrics (such as basal area, canopy cover, and mortality) deviate from the values predicted (modeled) under active fire conditions; they are considered more volatile (further away from an R^2 value of 1.0). It is desirable to have less volatility, which, in this case, means that the projected effects are closer to values that would be expected under active fire conditions, thereby more closely representing desired stand conditions.

C. DIRECT AND INDIRECT EFFECTS

Stand density, medium and large tree, mortality, and canopy cover direct and indirect effects will be analyzed alternative by alternative, whereas variability will be analyzed by comparing metrics between alternatives.

Alternative 1. Effects of the Proposed Action

The following tables (5-16) show the direct and indirect effects of treatments in the change from current condition to the immediate post treatment condition in some instances and 30 years post treatment in others. The subsequent indirect effects of the treatments can be traced through changes in average stand conditions over time as shown by stand density, medium and large trees, tree mortality, and canopy cover. Indirect effects of the proposed action are caused by the reduction in inter-tree competition that permits individual trees greater access to light, water and nutrients. Over time, this results in an observable growth response for height and diameter, especially in smaller diameter classes that have been released from competition from nearby brush and trees. Since the treatment areas would have improved growing conditions, overall resistance to environmental stress, including insect attack, drought, or disease, would improve.

In all tables, units have an abbreviation attached to the unit number in order to help orient the reader as to the existing condition of the unit (natural developed forest, natural young forest, plantation, and aspen) as well as the silviculture and fuels treatment method that would be used (mechanical, hand, pile burn, underburn and no treatment). Existing treatment unit conditions are more fully described in the "Affected Environment" section of the report, while the silviculture and fuels treatment method is thoroughly defined under each alternative's "Prescription and Treatment Method Definitions" section of the report.

Natural developed forest - **NDF**

Natural young forest - **YF**

Plantation - **P**

Aspen **- A**

Mechanical - **M**

Hand - **H**

Pile burn - **PB**

Underburn - **UB**

No Treatment - **NT**

Stand Density

Table 5 displays existing basal area as well as immediate post-treatment residual basal area and basal area 30 years after treatment under Alternative 1.

Table 5: Alternative 1 Basal Area: Existing Condition, Post- treatment, and 30 Years after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (Post Treatment) (sq. ft./ac.)	30 year Predicted Basal Area (Post Treatment) (sq. ft./ac.)
33 NDF, M, PB	118	1	4	**255**	174	254
		4	30		163	241

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (Post Treatment) (sq. ft./ac.)	30 year Predicted Basal Area (Post Treatment) (sq. ft./ac.)
		5	28		153	226
		6	56		149	217
			Weighted Unit Average Basal Area		**154**	**226**
34 **NDF, M, UB**	68	5	16	**218**	156	220
		6	47		145	203
		7	5		145	203
			Weighted Unit Average Basal Area		**148**	**207**
35 **NDF, M, PB**	64	1	8	**238**	158	224
		4	6		124	174
		5	7		151	214
		6	37		151	214
		7	6		138	194
			Weighted Unit Average Basal Area		**148**	**210**
36 **NDF, M, PB**	101	4	18	**264**	157	242
		5	13		158	242
		6	56		144	220
		7	14		134	207
			Weighted Unit Average Basal Area		**147**	**225**
38 **NDF, M, UB**	210	1	67	**223**	173	245
		4	7		158	225
		5	86		153	218
		7	50		139	198
			Weighted Unit Average Basal Area		**156**	**222**
39 **NDF, UB**	32	5	32	**235**	**210**	**303**
46 **P, M, UB**	621	4 (UB only)	47	**104**	93	169
		5	431		80	139
		6	105		80	139
		7	38		80	139
			Weighted Unit Average Basal Area		**81**	**141**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (Post Treatment) (sq. ft./ac.)	30 year Predicted Basal Area (Post Treatment) (sq. ft./ac.)
47 **P, UB**	33	5	33	**104**	**93**	**169**
61 **NDF, H, PB, UB**	20	1	15	**250**	174	255
		2	5		174	255
			Weighted Unit Average Basal Area		**174**	**255**
73 **NDF, M, UB**	144	4	6	**252**	160	220
		5	107		156	214
		6	27		148	203
		7	4		139	191
			Weighted Unit Average Basal Area		**154**	**211**
76 **YF, M, UB**	91	4 (UB only)	4	**136**	129	208
		5	37		103	163
		6	42		103	163
		7	8		103	163
			Weighted Unit Average Basal Area		**104**	**165**
80 **A, H, PB**	5	8	5	n/a	n/a	n/a
85 **NDF, M**	64	5	10	**208**	129	191
		6	53		137	202
		8	1		n/a	n/a
			Weighted Unit Average Basal Area		**136**	**200**
87 **P, M**	207	5	67	**127**	87	150
		6	130		87	150
		7	10		87	150
			Weighted Unit Average Basal Area		**87**	**150**
89 **NDF, M, UB**	34	4	6	**251**	152	212
		6	28		144	205
			Weighted Unit Average Basal Area		**145**	**206**
90 **NDF, M, UB**	40	6	40	**272**	**145**	**208**
91 **NDF, H, PB**	9	2	9	**188**	**171**	**215**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (Post Treatment) (sq. ft./ac.)	30 year Predicted Basal Area (Post Treatment) (sq. ft./ac.)
98 YF, H, PB	63	1	43	**143**	126	232
		2	9		126	232
		5	11		126	232
			Weighted Unit Average Basal Area		**126**	**232**
99 YF, H, PB	67	1	7	**144**	125	204
		2	4		125	204
		4	11		125	204
		5 (M only)	37		110	198
		6 (M only)	8		110	198
			Weighted Unit Average Basal Area		**115**	**200**
100 NDF, H, PB, UB	120	1	14	**204**	170	215
		2	19		170	215
		4	17		170	215
		5	46		162	204
		6	24		162	204
			Weighted Unit Average Basal Area		**165**	**209**
156 NDF, M, PB	84	1	84	**290**	**195**	**300**
163 NDF, M, PB, UB	82	1	29	**227**	170	240
		5	49		170	240
		7	4		154	216
			Weighted Unit Average Basal Area		**169**	**239**
213 NDF, M, PB	268	1	182	**292**	199	304
		2	11		177	265
		4	21		167	254
		5	18		171	262
		6	25		167	254
		7	11		157	241
			Weighted Unit Average Basal Area		**189**	**288**
282 NDF, H, PB, UB	108	2	46	**278**	208	255
		6	62		186	225
			Weighted		**195**	**238**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (Post Treatment) (sq. ft./ac.)	30 year Predicted Basal Area (Post Treatment) (sq. ft./ac.)
			Unit Average Basal Area			
Totals			**Total Weighted Unit Average Basal Area**	**196**	**135**	**202**

Table 5 shows the reduction in basal area from Alternative 1 treatments immediately and 30 years post treatment. This alternative would retain 69% of existing basal area, as shown in the total residual basal area compared to current basal area. This reduction in stand densities would reduce inter-tree competition as well as decrease probabilities of stand replacing disturbances. Further, as described under the variable thinning prescription and emphasis area discussion, ground and topographic conditions dictate where much of the remaining basal area resides. In other words, it is expected that Alternative 1's treatments would retain greater amounts of basal area in areas that would have supported higher stand densities under active fire conditions, while treatments would concentrate greater amounts of basal area reductions in areas that might not have been able to support as much basal area.

The reduction of basal area under Alternative 1 would enhance the resiliency of the treated stands within the Sagehen Project Area, particularly if one considers how much of the residual basal area would be composed of medium and large trees. The projections presented in Table 6 below indicate the degree of reduction in inter-tree competition from the treatments by the concentration of residual basal area in trees greater than 19.9 inches dbh, which would further enhance the resiliency of the remaining trees.

Table 6: Percentage of Basal Area in Trees greater than 19.9 inches dbh – Current and 30 Years after Treatment under Alternative 1.

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees >19.9 inches dbh	Predicted % of Basal Area in Trees >19.9 inches dbh in 30 years
33 NDF, M, PB	118	1	4	**41%**	67%
		4	30		69%
		5	28		70%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees >19.9 inches dbh	Predicted % of Basal Area in Trees >19.9 inches dbh in 30 years
		6	56		71%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**70%**
34 NDF, M, UB	68	5	16	**34%**	60%
		6	47		62%
		7	5		62%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**62%**
35 NDF, M, PB	64	1	8	**47%**	53%
		4	6		73%
		5	7		68%
		6	37		68%
		7	6		71%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**67%**
36 NDF, M, PB	101	4	18	**31%**	61%
		5	13		61%
		6	56		62%
		7	14		64%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**62%**
38 NDF, M, UB	210	1	67	**41%**	69%
		4	7		71%
		5	86		72%
		7	50		73%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**71%**
39 NDF, UB	32	5	32	**16%**	**51%**
46 P, M, UB	621	4 (UB only)	47	**4%**	11%
		5	431		17%
		6	105		17%
		7	38		17%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees >19.9 inches dbh	Predicted % of Basal Area in Trees >19.9 inches dbh in 30 years
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**17%**
47 **P, UB**	33	5	33	**4%**	**11%**
61 **NDF, H, PB, UB**	20	1	15	**17%**	48%
		2	5		48%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**48%**
73 **NDF, M, UB**	144	4	6	**42%**	70%
		5	107		71%
		6	27		72%
		7	4		73%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**71%**
76 **YF, M, UB**	91	4 (UB only)	4	**35%**	43%
		5	37		54%
		6	42		54%
		7	8		54%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**54%**
80 **A, H, PB**	5	8	5	n/a	n/a
85 **NDF, M**	64	5	10	43%	74%
		6	53		72%
		8	1	n/a	n/a
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh	**43%**	**72%**
87 **P, M**	207	5	67	**0%**	1%
		6	130		1%
		7	10		1%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**1%**
89	34	4	6		43%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees >19.9 inches dbh	Predicted % of Basal Area in Trees >19.9 inches dbh in 30 years
NDF, M, UB		6	28	**14%**	43%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**43%**
90 NDF, M, UB	40	6	40	**29%**	**66%**
91 NDF, H, PB	9	2	9	**34%**	**69%**
98 YF, H, PB	63	1	43	**22%**	40%
		2	9		40%
		5	11		40%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**40%**
99 YF, H, PB	67	1	7	**0%**	7%
		2	4		7%
		4	11		7%
		5 (M only)	37		6%
		6 (M only)	8		6%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**6%**
100 NDF, H, PB, UB	120	1	14	**56%**	76%
		2	19		76%
		4	17		76%
		5	46		79%
		6	24		79%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**78%**
156 NDF, M, PB	84	1	84	**33%**	**62%**
163 NDF, M, PB, UB	82	1	29	**48%**	73%
		5	49		73%
		7	4		75%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**73%**
213 NDF, M, PB	268	1	182	**45%**	76%
		2	11		80%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees >19.9 inches dbh	Predicted % of Basal Area in Trees >19.9 inches dbh in 30 years
		4	21		80%
		5	18		80%
		6	25		80%
		7	11		80%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**77%**
282 **NDF, H, PB, UB**	108	2	46	**44%**	83%
		6	62		95%
			Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh		**90%**
Totals			**Total Unit Weighted Average % of Basal Area in Trees >19.9 inches dbh**	**27%**	**49%**

Using the weighted average over the entire treatment units, Table 6 expresses a substantial increase of approximately 22 percent of the basal area in trees greater than 19.9 inches dbh 30 years post treatment. This movement can be attributed to both the removal of many of the smaller trees, as described in the suppressed cut prescription, which immediately moves the majority of the remaining basal area into larger size classes, as well as the improved growth over a 30-year period which occurs as a result of the increased amount of available resources for the remaining trees to utilize. The combination of reducing basal area and increasing the amount of that basal area in trees greater than 19.9 inches dbh after 30 years reduces the total number of trees, most of which are smaller. Ultimately, this diminishes density related stresses on the remaining tree population, which will increase tree resiliency to disturbance which in turn reduces probabilities of that disturbance to become a stand replacing disturbance.

Medium and Large Trees

Not only can the values displayed in Table 6 provide an indication of stand resilience, they also demonstrate medium and large tree populations relative to other size classes. Under current conditions, as shown above in Table 6, the majority of the basal area is in trees smaller than 19.9 inches dbh, which creates a reverse-J diameter distribution (with large numbers of small trees and relatively few large-diameter trees). GTR-220 explains, “Research suggests that fire prone forests rarely had reverse-J diameter distributions” (North et al., 2009). The reduction of basal area combined with movement of the basal area to medium and large trees as displayed in Tables 5 and 6 not only reduces density stresses within the treatment units, but also moves the units away from existing reverse-J diameter distributions (majority of the basal area in smaller trees). Approximately 49 percent of the basal area in medium and large trees is projected in 30 years across the project area’s treatment units. However, treatment units with natural developed forest conditions would have approximately 71 percent of their basal area in medium and large trees 30 years post treatment, which is consistent with what research suggests as a diameter distribution for a fire-prone forest (North et al., 2009).

Although the majority of the basal area removed would be in trees less than 20 inches dbh, there are some instances that would warrant the removal of trees between 20 inches dbh and 29.9 inches dbh in order to meet project goals. Table 7 shows the amount of trees per acre in different size classes marked for removal in the “mechanical thinning” units of the project. (The other units have tree cutting, but the maximum tree size that is proposed to be felled is 15.9 inches dbh).

Table 7: Alternative 1: Size Class Breakdown of Trees greater than 9.9 inches dbh Marked for Removal on Average per Acre (all mechanically thinned units – 2,105 acres)

Project Unit	Total Unit Acres	Average Trees per Acre Marked for Removal 10 – 19.9 inches dbh	Average Trees per Acre Marked for Removal 20 – 29.9 inches dbh	Average Trees per Acre Marked for Removal > 30 inches dbh
Unit 33 NDF	118	26	0	0
Unit 34 NDF	68	26	0	0
Unit 35 NDF	64	24	0	0
Unit 36 NDF	101	31	1	0
Unit 38 NDF	210	13	13	0
Unit 46 P	621	67	0	0
Unit 73 NDF	144	26	.2	0
Unit 85 NDF	64	11	0	0
Unit 87 P	207	68	0	0
Unit 89 NDF	34	36	0	0
Unit 90	40	47	0	0

Project Unit	Total Unit Acres	Average Trees per Acre Marked for Removal 10 – 19.9 inches dbh	Average Trees per Acre Marked for Removal 20 – 29.9 inches dbh	Average Trees per Acre Marked for Removal > 30 inches dbh
NDF				
Unit 156 NDF	84	27	0	0
Unit 163 NDF	82	25	0	0
Unit 213 NDF	268	15	6	0
Weighted Average		**40**	**2**	**0**

The concentration of trees between 20 and 29.9 inches dbh marked for removal in a few units is a positive indicator that Sagehen Project tree marking crews understood and followed marking guidelines which implements the intent of the silviculture and fuels prescriptions. As shown in Table 7, only four units have trees marked for removal that are between 20 and 29.9 inches dbh. The data displayed in Table 7 should be considered with two caveats. First, cruise designs carry a certain amount of error. In this case, the error was approximately 16 percent for the greater than 10- inch dbh component. Although statistically acceptable for the purposes of contract preparation, this error may include some medium and large trees that were marked for removal, but not sampled in the smallest units and therefore not in this table. However, the vast majority of medium and large trees should be accounted for and none over 29.9 inches dbh were marked for removal. Second, many of the units that are slated for "mechanical thinning" have similar prescriptions; those prescriptions, as stated above, are interpreted using site specific conditions. This means that while, in some cases, marking medium and large trees for removal is warranted, in others, it may not be. One consideration is the existence of relatively higher amounts of basal area combined with relatively higher amounts of basal area in medium and large trees. For example, if one cross references the treatment units where trees between 20 and 29.9 inches dbh were marked for removal (Tables 7 and 8) with the amount of basal area and percent of basal area in larger trees those units currently hold (Tables 5 and 6), one would expect some of the highest basal area values combined with some of the highest percentages of that basal area in medium and large trees to correspond with more medium and large trees being marked for removal. Table 8 shows the corresponding basal area and percent of basal area in medium and large trees in the units where trees between 20 and 29.9 inches dbh were marked for removal. The weighted percentile was then calculated for these units with respect to where they fall, in statistical terms of basal area and percentage of basal area in medium and large trees, within all mechanically thinned units.

Table 8: Alternative 1: Basal Area and Percentage of Basal Area in Medium and Large Trees (all mechanically thinned units with 20-29.9 inch dbh tree removal)

Project Unit	Total Unit Acres	Trees 20 – 29.9 inches dbh per Acre Marked for Removal	Current Weighted Average Unit Basal Area	Current Weighted Average Unit % of Basal Area in Trees >19.9 inches dbh	Current Basal Area Combined with % of Basal Area in Trees >19.9 inches dbh (weighted percentile within mechanical units)
Unit 36 NDF	101	1	210	31%	62%
Unit 38 NDF	210	13	198	35%	92%
Unit 73 NDF	144	0.2	194	35%	69%
Unit 213 NDF	268	6	220	39%	99%

Table 8 helps exemplify how site conditions ultimately drove how the prescriptions were applied. In areas where there is an existing higher amount of basal area combined with higher percentages of the basal area in medium and large trees, proportionally higher amounts of medium and large trees are marked for removal in order to meet Sagehen Project goals, for example strategic basal area reductions for variability and wildlife habitat improvement. In other words, although the prescriptions require the largest trees to be left, if most of the existing trees are medium- and large-sized, then some will be marked for removal. In units where most trees are less than 20 inches dbh, then the medium and large trees are retained.

Although size classes are generally displayed in 9.9-inch ranges, it may help the discussion to split out whether the majority of those trees are at the upper or lower end of that range considering the intent of the prescriptions is to leave the largest trees when given the choice. Table 9 shows how many trees are marked for removal in size class 20-22.9 inches dbh and how many trees are marked for removal in size class 23-29.9 inches dbh.

Table 9: 20-29.9 inch dbh Size Class Breakdown of Trees Marked for Removal per Acre in all mechanically thinned units – 2,105 acres

Size Class @ dbh	# of Trees Marked for Removal per Acre

20-22.9 inches	2
23-29.9 inches	.1
Totals	**2.1**

Of the trees marked for removal greater than 10 inches dbh, only about 5 percent of those trees were between 20 inches dbh and 22.9 inches dbh. Only 1.4 percent of **all** trees marked for removal were between 20 inches dbh and 22.9 inches dbh. While only about 0.3 percent of trees marked for removal greater than ten inches dbh, and only 0.1 percent of **all** trees marked for removal were between 23 inches dbh and 29.9 inches dbh (these percentages include medium and large trees marked for removal under the early seral opening prescription). These figures mirror the intent of the prescriptions by focusing the majority of the removal on trees under 20 inches dbh and those trees that were to be selected for removal between 20.9 inches dbh and 29.9 inches dbh would be relatively rare and would be mostly comprised of the lower end of that size class.

It is important, however, to compare the populations of existing trees by size class to what is being removed so effects can be appropriately measured.

Table 10 shows the existing tree population (greater than 9.9 inches dbh) in the treatment units before treatment.

Table 10: Existing Numbers of Trees by Size Class in the Sagehen Project Treatment Units

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Existing Number of Trees 10-19.9 inches dbh per Acre	Existing Number of Trees 20-29.9 inches dbh per Acre	Existing Number of Trees 30 inches dbh + per Acre
33 NDF	118	1	4	**107.8**	**26.2**	**4.0**
		4	30			
		5	28			
		6	56			
34 NDF	68	5	16	**97.9**	**15.8**	**3.2**
		6	47			
		7	5			
35 NDF	64	1	8	**101.7**	**21.4**	**5.3**
		4	6			
		5	7			
		6	37			
		7	6			
36 NDF	101	4	18	**131.1**	**22.5**	**1.3**
		5	13			
		6	56			
		7	14			

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Existing Number of Trees 10-19.9 inches dbh per Acre	Existing Number of Trees 20-29.9 inches dbh per Acre	Existing Number of Trees 30 inches dbh + per Acre
38 **NDF**	210	1	67	**105.0**	**24.6**	**2.4**
		4	7			
		5	86			
		7	50			
39 **NDF**	32	5	32	**131.1**	**16.0**	**0**
46 **P**	621	4	47	**80.3**	**0.4**	**0.4**
		5	431			
		6	105			
		7	38			
47 **P**	33	5	33	**80.3**	**0.4**	**0.4**
61 **NDF**	20	1	15	**145.5**	**13.3**	**0**
		2	5			
73 **NDF**	144	4	6	**96.5**	**22.3**	**4.7**
		5	107			
		6	27			
		7	4			
76 **YF**	91	4	4	**54.7**	**8.0**	**3.4**
		5	37			
		6	42			
		7	8			
80 **A**	5	8	5	n/a	n/a	n/a
85 **NDF**	64	5	10	**86.9**	**25.9**	**1.8**
		6	53			
		8	1			
87 **P**	207	5	67	**126.0**	**0**	**0**
		6	130			
		7	10			
89 **NDF**	34	4	6	**159.9**	**5.3**	**2.7**
		6	28			
90 **NDF**	40	6	40	**132.6**	**18.4**	**5.3**
91 **NDF**	9	2	9	**97.6**	**23.4**	**0**
98 **YF**	63	1	43	**51.5**	**8.0**	**1.6**
		2	9			
		5	11			
99 **YF**	67	1	7	**97.6**	**0**	**0**
		2	4			

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Existing Number of Trees 10-19.9 inches dbh per Acre	Existing Number of Trees 20-29.9 inches dbh per Acre	Existing Number of Trees 30 inches dbh + per Acre
		4	11			
		5	37			
		6	8			
100 **NDF**	120	1	14	**62.5**	**16.5**	**7.3**
		2	19			
		4	17			
		5	46			
		6	24			
156 **NDF**	84	1	84	**134.5**	**26.4**	**2.7**
163 **NDF**	82	1	29	**83.1**	**28.4**	**2.3**
		5	49			
		7	4			
213 **DF**	268	1	182	**113.2**	**32.6**	**4.3**
		2	11			
		4	21			
		5	18			
		6	25			
		7	11			
282 **NDF**	108	2	46	**119.5**	**23.5**	**9.3**
		6	62			
Total			**Total Weighted Average of Existing Trees Per Acre**	**98.8**	**14.7**	**2.6**

On average across all of the Project Area's treatment units, there are approximately 17 trees per acre over 19.9 inches dbh. If units that are in an early seral stage (plantations and natural young forests) are removed from consideration, approximately 28 medium and large trees per acre exist in the remaining treatment units (occupied by natural developed forest stands). Subtracting trees proposed for removal under Alternative 1, as shown in Tables 7-10, results in a 7 percent reduction in the medium and large trees across these treatment units.

While a 7 percent reduction may seem small when discussing a particular size class reduction, considering other goals are being met with the medium and large tree removal component, it is imperative to discuss the numbers of medium and large trees to be retained and whether that population of remaining medium and large trees is similar to levels expected with active fire conditions under an active fire regime.

In order to verify the remaining medium and large tree population, two sets of data will be analyzed for similarities. (1) FVS predicted tree populations after all prescriptions (except for DCAs and ESOs) have been implemented shown in Table 11 and (2) the two mechanically treated test areas that confirm remaining tree populations after the same prescription protocol was fully implemented shown in Tables 12 and 13. These two 3-acre sites can be extrapolated to the larger Project Area units with natural developed forest conditions.

Table 11: Alternative 1: Remaining Number of Trees Post Treatment by Size Class Outside of DCAs and ESOs Predicted by FVS

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Remaining Number of Trees 10-19.9 inches dbh per Acre	Remaining Number of Trees 20-29.9 inches dbh per Acre	Remaining Number of Trees 30 inches dbh + per Acre
33 NDF, M, PB	118	1	4	59.9	26.2	4.0
		4	30	55.4	25.1	4.0
		5	28	51.0	23.8	4.0
		6	56	48.1	22.9	4.0
			Unit Weighted Average of Remaining Trees Per Acre	**51.0**	**23.8**	**4.0**
34 NDF, M, UB	68	5	16	74.7	15.9	3.2
		6	47	65.7	15.2	3.2
		7	5	65.7	15.2	3.2
			Unit Weighted Average of Remaining Trees Per Acre	**67.8**	**15.4**	**3.2**
35 NDF, M, PB	64	1	8	54.1	17.7	6.6
		4	6	33.9	13.5	6.5
		5	7	52.0	16.1	6.5
		6	37	52.0	16.1	6.5
		7	6	41.8	15.5	6.5
			Unit Weighted	**49.6**	**16.0**	**6.5**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Remaining Number of Trees 10-19.9 inches dbh per Acre	Remaining Number of Trees 20-29.9 inches dbh per Acre	Remaining Number of Trees 30 inches dbh + per Acre
			Average of Remaining Trees Per Acre			
36 **NDF, M, PB**	101	4	18	67.3	19.1	1.3
		5	13	67.3	19.1	1.3
		6	56	56.0	18.1	1.3
		7	14	53.2	17.2	1.3
			Unit Weighted Average of Remaining Trees Per Acre	**59.1**	**18.3**	**1.3**
38 **NDF, M, UB**	210	1	67	74.3	24.6	2.4
		4	7	65.9	23.0	2.4
		5	86	60.9	23.0	2.4
		7	50	51.7	21.9	2.4
			Unit Weighted Average of Remaining Trees Per Acre	**63.1**	**23.2**	**2.4**
39 **NDF, UB**	32	5	32	**134.5**	**17.2**	**0.0**
46 **P, M, UB**	621	4 (UB only)	47	80.0	0.9	0.4
		5	431	80.5	0.9	0.4
		6	105	80.5	0.9	0.4
		7	38	80.5	0.9	0.4
			Unit Weighted Average of Remaining Trees Per Acre	**80.5**	**0.9**	**0.4**
47 **P, UB**	33	5	33	**80.0**	**0.9**	**0.4**
61 **NDF, H, PB, UB**	20	1	15	102.0	13.3	0.0
		2	5	102.0	13.3	0.0
			Unit Weighted Average of Remaining Trees Per	**102.0**	**13.3**	**0.0**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Remaining Number of Trees 10-19.9 inches dbh per Acre	Remaining Number of Trees 20-29.9 inches dbh per Acre	Remaining Number of Trees 30 inches dbh + per Acre
			Acre			
73 NDF, M, UB	144	4	6	51.3	20.2	4.7
		5	107	49.0	20.2	4.7
		6	27	45.7	19.1	4.7
		7	4	38.7	18.5	4.7
			Unit Weighted Average of Remaining Trees Per Acre	**48.2**	**19.9**	**4.7**
76 YF, M, UB	91	4 (UB only)	4	56.6	8.8	3.4
		5	37	37.9	8.7	3.3
		6	42	37.9	8.7	3.3
		7	8	37.9	8.7	3.3
			Unit Weighted Average of Remaining Trees Per Acre	**38.7**	**8.7**	**3.3**
80 A	5	8	5	n/a	n/a	n/a
85 NDF, M	64	5	10	37.2	24.7	1.8
		6	53	39.6	25.9	1.8
		8	1	n/a	n/a	n/a
			Unit Weighted Average of Remaining Trees Per Acre	**39.2**	**25.7**	**1.8**
87 P, M	207	5	67	102.0	0	0
		6	130	102.0	0	0
		7	10	102.0	0	0
			Unit Weighted Average of Remaining Trees Per Acre	**102.0**	**0**	**0**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Remaining Number of Trees 10-19.9 inches dbh per Acre	Remaining Number of Trees 20-29.9 inches dbh per Acre	Remaining Number of Trees 30 inches dbh + per Acre
89 **NDF, M, UB**	34	4	6	116.0	7.0	2.7
		6	28	107.3	7.0	2.7
			Unit Weighted Average of Remaining Trees Per Acre	**108.8**	**7.0**	**2.7**
90 **NDF, M, UB**	40	6	40	**62.5**	**17.7**	**5.3**
91 **NDF, H, PB**	9	2	9	**77.2**	**23.6**	**0**
98 **YF, H, PB**	63	1	43	42.9	8.0	1.6
		2	9	42.9	8.0	1.6
		5	11	42.9	8.0	1.6
			Unit Weighted Average of Remaining Trees Per Acre	**42.9**	**8.0**	**1.6**
99 **YF, H, PB**	67	1	7	92.4	0	0
		2	4	92.4	0	0
		4	11	92.4	0	0
		5 (M only)	37	81.1	0	0
		6 (M only)	8	81.1	0	0
			Unit Weighted Average of Remaining Trees Per Acre	**84.8**	**0**	**0**
100 **NDF, H, PB, UB**	120	1	14	38.8	17.1	7.3
		2	19	38.8	17.1	7.3
		4	17	38.8	17.1	7.3
		5	46	33.6	17.1	7.3
		6	24	33.6	17.1	7.3
			Unit Weighted Average of Remaining Trees Per Acre	**35.8**	**17.1**	**7.3**
156	84	1	84	**85.3**	**24.0**	**2.7**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Remaining Number of Trees 10-19.9 inches dbh per Acre	Remaining Number of Trees 20-29.9 inches dbh per Acre	Remaining Number of Trees 30 inches dbh + per Acre
NDF, M, PB						
163 NDF, M, PB, UB	82	1	29	56.1	27.1	3.4
		5	49	56.1	27.1	3.4
		7	4	46.6	25.2	3.4
			Unit Weighted Average of Remaining Trees Per Acre	**55.6**	**27.0**	**3.4**
213 NDF, M, PB	268	1	182	61.3	28.2	5.4
		2	11	49.6	25.7	5.3
		4	21	45.7	24.6	5.3
		5	18	48.0	25.6	5.3
		6	25	45.7	24.6	5.3
		7	11	42.9	22.5	5.3
			Unit Weighted Average of Remaining Trees Per Acre	**56.5**	**27.1**	**5.4**
282 NDF, H, PB, UB	108	2	46	57.0	24.0	9.3
		6	62	34.5	24.1	9.3
			Unit Average Unit Weighted Average of Remaining Trees Per Acre	**44.1**	**24.1**	**9.3**
Totals			**Total Weighted Average of Remaining Trees Per Acre**	**66.9**	**13.6**	**2.8**

FVS predicts that approximately 16 medium and large trees per acre will remain across all units, post treatment (not including DCAs and ESOs). However, this average includes areas that have been affected by stand replacing fire and are now in a young forest condition (although there are a small number of residual medium and large trees present in some of these stands). In order to effectively assess the remaining medium and large tree population under implementation of Alternative 1, compared to what might have existed in later seral stands that had developed with active fire, the analysis further considers natural developed forest stands' medium and large tree populations. FVS predicts approximately 25 medium and large trees per acre would remain on average in the treatment units with natural developed forest conditions post treatment (minus DCAs and ESOs) under Alternative 1.

Tables 12 and 13 give an example of residual medium and large tree populations as a result of project prescriptions being applied to the two 3- acre test plots in natural developed forest conditions.

Table 12: Lower Elevation (less than 7,000 feet) Test Plot Residual Number of Trees per Acre (greater than ten inches dbh)

Size Class at dbh (inches)	Pine Trees per Acre	Fir Trees per Acre	Total # of Trees per Acre	% Total of Trees greater than 9.9 inches dbh
10-19.9	45	19	64	72%
20-29.9	15	5	20	22%
30 +	4	1	5	6%
Totals	**64**	**25**	**89**	**100%**

Table 13: Upper Elevation (greater than 7,000 feet) Test Plot Residual Number of Trees per Acre (greater than ten inches dbh)

Size Class at dbh (inches)	Pine Trees per Acre	Fir Trees per Acre	Total # of Trees per Acre	% Total of Trees greater than 9.9 inches dbh
10-19.9	24	33	57	63%
20-29.9	2	20	22	25%
30 +	1	10	11	12%
Totals	**27**	**63**	**90**	**100%**

The test plots represent units with natural developed forest conditions and show that 25 medium and large trees per acre remained on the lower elevation test plot and 33 medium and large trees per acre remained on the upper elevation test plot.

When comparing the test plots to the FVS predictions, it is apparent that there is some correlation between these two methods of predicting how many trees would remain, on average, in Project Area units (with natural developed forest conditions) after all prescriptions have been implemented. FVS predicts Project Area units, with natural developed forest conditions, would average about 25 medium and large trees per acre remaining while data collected from the test plots show between 25 and 33 medium and large trees per acre remaining in the treated areas. (Test plots do include DCA and ESO prescriptions, where FVS predictions do not.) Based on this information, Alternative 1 prescriptions are expected to retain between 25 and 33 medium and large trees per acre in units that have natural developed forest conditions, and those trees that remain would be the largest trees in the existing stands. No medium and large trees would be removed in units that are classified as plantations or have natural young forest conditions.

To place effects of Alternative 1 on medium and large tree populations context requires a practical comparison of what kind of populations existed in a similar ecosystem under with active fire conditions. A study by Alan H. Taylor (2004), titled "Identifying Forest Reference Conditions on Early Cut-over Lands, Lake Tahoe Basin, USA" was conducted along the east shore of the Lake Tahoe area on Comstock era logging stumps to assess diameter distributions of pre-settlement forests. These pre-settlement forests were shaped by active fire conditions, were under an active fire regime and had little to no logging up until the Comstock logging began. The results of this study, particularly the historical population of medium and large trees in a Sierran conifer forest with active fire conditions under an active fire regime, could help inform this analysis regarding amounts of medium and large trees in a given area. Although this study is quite close to the Project Area and shares many ecological similarities, like other research metrics, it may not be appropriate to apply exact numbers on a medium and large tree population under active fire conditions for a few reasons. First, this study is conducted further east of the Sierra crest rain shadow than the Sagehen Project Area. Therefore the Sagehen Project Area gets more precipitation, which may provide for an environment that could support more and larger trees. Thus, associating this studies' numbers with the Sagehen Project might, at times, underestimate potential numbers of medium and large trees within the Sagehen Project Area. Also, diameters could only be measured at stump height where Sagehen Project metrics discuss tree diameters taken at breast height (4 ½ feet above ground). Measuring at stump height might include more trees that are considered medium and large because measurements were taken at the largest part of the tree, the base. Therefore, associating this study's numbers with the Sagehen Project might, at times, overestimate a desirable medium and large tree distribution within the Sagehen Project Area. Either way, this study provides valuable insight on whether or not the removal of some medium and large trees from an existing population of medium and large trees puts Sagehen Project units on a similar trajectory to that of a forest under active fire conditions. Taylor found that in Jeffrey pine-white fir forests, similar to Sagehen Project natural developed forest units, there were between 18 and 36 medium and large trees per acre on the landscape, under active fire conditions with minimal logging (Taylor 2004). This spread is actually quite consistent with the 20 to 33 medium and large trees that both FVS and the test plots predict. The trees found in Taylor's study encompass many more and larger diameter classes, but project prescriptions can only facilitate opportunities for increased growth rates and resilience since Sagehen Project Area units are at an earlier successional stage than what was being measured at Lake Tahoe. Therefore, the remaining amount of medium and large trees within the Sagehen Project Area is not an unusual number when compared to what existed under an active fire regime with active fire conditions in a similar ecosystem.

Alternative 1 prescriptions move Project Area basal area towards diameter distributions consistent with active fire conditions under active fire regime forests. Further, even with some removal of selected trees greater than 20 inches dbh in order to meet project goals, Alternative 1 would have a minimal effect on the overall medium and large tree population within the Sagehen Project Area. Removing no trees above 30 inches dbh and only approximately 2 trees between 20 inches dbh and 29.9 inches dbh on average per acre would leave sufficient medium and large structures to meet other project goals and ensure a population of medium and large, living trees on the landscape that is consistent with what would have likely been present under active fire conditions. Further, the removal of the trees shown in Tables 7-9 ensure those remaining medium and large trees have the available resources to thrive and have the best opportunity to acquire old growth characteristics.

Tree Mortality

Tables 5 and 6 display the reduction in basal area and movement of that basal area into medium and large trees for Alternative 1. This movement of basal area is not aimed at eliminating mortality, but at capturing a certain amount of mortality and concentrating it in larger trees, without making a stand susceptible to stand replacing disturbances. One way to calculate the rate of mortality is to measure how much of the forest will die within a given year compared to the amount of forested volume in a given stand. A study on the Plumas National Forest, to the north of the Sagehen Project Area, recorded an annual mortality rate of 0.6 percent (Ansley and Battles 1998). This study site was in old growth mixed conifer forest with minimal logging influences, but the current condition was a consequence of a century of fire suppression. Although 0.6 percent may, at first glance, seem insignificant, extrapolating that value to a stand of trees puts it in perspective. For example, a 200 acre stand with approximately 300 trees per acre, with 0.6 percent mortality would have 360 trees die every year or almost two trees would die every acre every year. Interpolating this out, because so many trees would die every year, most of the remaining trees would not likely live another 150 years. This is undesirable because the stand’s trees would have trouble acquiring old growth characteristics during that shortened timespan. It is known, however, that mortality rates are rarely constant and difficult to forecast where mortality might occur. Therefore, this scenario is designed to simply illustrate what that mortality rate may mean for a stand of trees over time and is not aimed at predicting a persistent mortality rate nor where that mortality might occur. Compare this study to a Sierra San Pedro Martir (SSPM) old growth mixed conifer stand that has had no logging influences or fire suppression and its mortality rate is only 0.162 percent (Stephens and Gill 2005). In the same stand scenario where you have a 200 acre stand with 300 trees per acre, 0.162 percent mortality would equate to about 100 trees dying each year or one tree would die every acre every other year. This scenario represents four times less trees dying with only a 0.44 percent decrease in mortality. Mortality, in this case, would most likely not limit the acquisition of old growth characteristics by most of those trees because their life span would be maximized (the trees would be likely to reach an older age before they died). Again, these scenarios are designed to simply illustrate what a particular mortality rate may mean for a stand of trees over time and is not aimed at predicting a constant mortality rate nor where that mortality might occur.

Table 14 shows current mortality rates and predicted mortality rates 30 years after treatment. It is important to note, that these stands have had a century of fire suppression and are mostly second growth forest resulting from logging in the late 1800s/early 1900s. Therefore, using mortality metrics from the SSPM and Plumas National Forest study plots to directly determine goals for the Sagehen Project is not appropriate, but can, at least, frame a discussion on desirable levels of mortality in these stands.

Table 14: Alternative 1: FVS Predicted Annual Mortality Rate – Existing Condition and 30 Years after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality (FVS Calculated)	30 year FVS Predicted % of Mortality (Post Treatment)
33 NDF, M, PB	118	1	4	**0.53%**	0.45%
		4	30		0.17%
		5	28		0.16%
		6	56		0.15%
			Weighted Average % of Mortality		**0.17%**
34 NDF, M, UB	68	5	16	**0.52%**	0.14%
		6	47		0.16%
		7	5		0.16%
			Weighted Average % of Mortality		**0.16%**
35 NDF, M, PB	64	1	8	**0.50%**	0.15%
		4	6		0.15%
		5	7		0.14%
		6	37		0.14%
		7	6		0.15%
			Weighted Average % of Mortality		**0.14%**
36 NDF, M, PB	101	4	18	**0.51%**	0.14%
		5	13		0.14%
		6	56		0.14%
		7	14		0.15%
			Weighted Average % of Mortality		**0.14%**
38 NDF, M, UB	210	1	67	**0.15%**	0.17%
		4	7		0.17%
		5	86		0.18%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality (FVS Calculated)	30 year FVS Predicted % of Mortality (Post Treatment)
		7	50		0.18%
			Weighted Average % of Mortality		**0.18%**
39 NDF, UB	32	5	32	**0.66%**	**0.48%**
46 P, M, UB	621	4 (UB only)	47	**0.07%**	0.13%
		5	431		0.16%
		6	105		0.16%
		7	38		0.16%
			Weighted Average % of Mortality		**0.16%**
47 P, UB	33	5	33	**0.07%**	**0.13%**
61 NDF, H, PB, UB	20	1	15	**0.54%**	0.49%
		2	5		0.49%
			Weighted Average % of Mortality		**0.49%**
73 NDF, M, UB	144	4	6	**0.46%**	0.15%
		5	107		0.15%
		6	27		0.14%
		7	4		0.15%
			Weighted Average % of Mortality		**0.15%**
76 YF, M, UB	91	4 (UB only)	4	**0.07%**	0.10%
		5	37		0.10%
		6	42		0.10%
		7	8		0.10%
			Weighted Average % of Mortality		**0.10%**
80 A, H, PB	5	8	5	n/a	n/a
85 NDF, M	64	5	10	0.12%	0.16%
		6	53		0.17%
		8	1	n/a	n/a
			Weighted Average % of Mortality	**0.12%**	**0.17%**
87 P, M	207	5	67	**0.12%**	0.18%
		6	130		0.18%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality (FVS Calculated)	30 year FVS Predicted % of Mortality (Post Treatment)
		7	10		0.18%
			Weighted Average % of Mortality		**0.18%**
89 NDF, M, UB	34	4	6	**1.79%**	0.45%
		6	28		0.45%
			Weighted Average % of Mortality		**0.45%**
90 NDF, M, UB	40	6	40	**0.48%**	**0.16%**
91 NDF, H, PB	9	2	9	**0.77%**	**1.17%**
98 YF, H, PB	63	1	43	**0.10%**	0.54%
		2	9		0.54%
		5	11		0.54%
			Weighted Average % of Mortality		**0.54%**
99 YF, H, PB	67	1	7	**1.36%**	1.78%
		2	4		1.78%
		4	11		1.78%
		5 (M only)	37		0.68%
		6 (M only)	8		0.68%
			Weighted Average % of Mortality		**1.04%**
100 NDF, H, PB, UB	120	1	14	**0.37%**	0.11%
		2	19		0.11%
		4	17		0.11%
		5	46		0.12%
		6	24		0.12%
			Weighted Average % of Mortality		**0.12%**
156 NDF, M, PB	84	1	84	**0.50%**	**0.49%**
163 NDF, M, PB, UB	82	1	29	**0.67%**	0.19%
		5	49		0.19%
		7	4		0.19%
			Weighted Average % of Mortality		**0.19%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality (FVS Calculated)	30 year FVS Predicted % of Mortality (Post Treatment)
213 NDF, M, PB	268	1	182	**0.59%**	0.44%
		2	11		0.17%
		4	21		0.17%
		5	18		0.17%
		6	25		0.17%
		7	11		0.16%
			Weighted Average % of Mortality		**0.35%**
282 NDF, H, PB, UB	108	2	46	**1.09%**	0.34%
		6	62		0.17%
			Weighted Average % of Mortality		**0.24%**
Totals			**Total Weighted Average % of Mortality**	**0.38%**	**0.24%**

On average, mortalities would be kept at approximately 0.24 percent even after 30 years. Using the above examples, in a 200-acre stand with 300 trees per acre, approximately 144 trees would die each year, which is less than 1 tree per acre per year. Hence, the projected overall mortality rate would allow trees within the stands treated under Alternative 1 to reach ages that often have old growth characteristics. It is known, however, that mortality rates are rarely constant and difficult to forecast where mortality might occur. Therefore, this scenario is designed to simply illustrate what that mortality rate may mean for a stand of trees over time and is not aimed at predicting a persistent mortality rate nor where that mortality might occur. Further, with the majority of the basal area in medium and large trees as shown in Table 6, combined with the decadent feature enhancement prescription, would provide more control over where that mortality would occur.

Table 15 shows the FVS predicted current percentage of trees greater than 14.9 inches dbh expected to die on an annual basis as well as the predicted percentage of trees greater than 14.9 inches dbh expected to die on an annual basis after 30 years. This provides some insight on whether the mortality rate in table 14 is occurring in mostly smaller or larger trees.

Table 15: Alternative 1: Percentage of All Trees Expected to die on an Annual Basis that are Greater than 14.9 inches dbh – 30 Years after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
33 NDF, M, PB	118	1	4	**8%**	46%
		4	30		54%
		5	28		56%
		6	56		58%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**56%**
34 NDF, M, UB	68	5	16	**11%**	1%
		6	47		52%
		7	5		52%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**40%**
35 NDF, M, PB	64	1	8	**9%**	52%
		4	6		59%
		5	7		52%
		6	37		52%
		7	6		58%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**53%**
36 NDF, M, PB	101	4	18	**5%**	41%
		5	13		41%
		6	56		40%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
		7	14		44%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**41%**
38 NDF, M, UB	210	1	67	**14%**	56%
		4	7		61%
		5	86		59%
		7	50		61%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**59%**
39 NDF, UB	32	5	32	**4%**	**24%**
46 P, M, UB	621	4 (UB only)	47	**0%**	21%
		5	431		47%
		6	105		47%
		7	38		47%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**45%**
47 P, UB	33	5	33	**0%**	**21%**
61 NDF, H, PB, UB	20	1	15	**2%**	**27%**
		2	5		
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		
73 NDF, M, UB	144	4	6	**8%**	41%
		5	107		44%
		6	27		44%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
		7	4		43%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**44%**
76 YF, M, UB	91	4 (UB only)	4	**2%**	14%
		5	37		21%
		6	42		21%
		7	8		21%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**21%**
80 A, H, PB	5	8	5	n/a	n/a
85 NDF, M	64	5	10	11%	62%
		6	53		56%
		8	1	n/a	n/a
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh	**11%**	**57%**
87 P, M	207	5	67	**0%**	62%
		6	130		62%
		7	10		62%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**62%**
89 NDF, M, UB	34	4	6	**2%**	42%
		6	28		41%
			Weighted Average % of Mortality in		**41%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
			Trees greater than 14.9 inches dbh		
90 NDF, M, UB	40	6	40	**5%**	**44%**
91 NDF, H, PB	9	2	9	**16%**	**68%**
98 YF, H, PB	63	1	43	**2%**	14%
		2	9		14%
		5	11		14%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**14%**
99 YF, H, PB	67	1	7	**1%**	28%
		2	4		28%
		4	11		28%
		5 (M only)	37		26%
		6 (M only)	8		26%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**27%**
100 NDF, H, PB, UB	120	1	14	**13%**	47%
		2	19		47%
		4	17		47%
		5	46		53%
		6	24		53%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**50%**
156 NDF, M, PB	84	1	84	**5%**	**38%**
163 NDF, M, PB, UB	82	1	29	**10%**	59%
		5	49		59%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
		7	4		62%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**59%**
213 NDF, M, PB	268	1	182	**12%**	54%
		2	11		69%
		4	21		68%
		5	18		68%
		6	25		68%
		7	11		65%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**58%**
282 NDF, H, PB, UB	108	2	46	**15%**	64%
		6	62		94%
			Weighted Average % of Mortality in Trees greater than 14.9 inches dbh		**81%**
Totals			**Total Weighted Average % of Mortality in Trees greater than 14.9 inches dbh**	**6%**	**49%**

Treatments are predicted to increase the weighted average annual percent of trees greater than 14.9 inches dbh expected to die by as much as 43 percent in 30 years. This means that in 30 years, almost half of all the trees dying will be in trees over 14.9 inches dbh. Therefore as shown in table 14, although mortality rates decrease to more sustainable rates over time, that mortality, as shown in table 15, is more concentrated in trees greater than 14.9 inches dbh. This trend is much more consistent with conditions associated with a forest ecosystem that experienced active fire under an active fire regime than what stands are currently experiencing.

Canopy Cover:

Table 16 compares predicted residual canopy cover under Alternative 1 with current conditions.

Table 16: Alternative 1: Canopy Cover before and after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Canopy Cover	Predicted Residual Canopy Cover
33 NDF, M, PB	118	1	4	**71%**	54%
		4	30		51%
		5	28		49%
		6	56		38%
			Weighted Unit Average Canopy Cover		**44%**
34 NDF, M, UB	68	5	16	**70%**	55%
		6	47		52%
		7	5		52%
			Weighted Unit Average Canopy Cover		**53%**
35 NDF, M, PB	64	1	8	**68%**	41%
		4	6		42%
		5	7		49%
		6	37		49%
		7	6		46%
			Weighted Unit Average Canopy Cover		**47%**
36 NDF, M, PB	101	4	18	**75%**	44%
		5	13		54%
		6	56		51%
		7	14		48%
			Weighted Unit Average Canopy Cover		**50%**
38	210	1	67	**63%**	52%

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Canopy Cover	Predicted Residual Canopy Cover
NDF, M, UB		4	7		50%
		5	86		49%
		7	50		46%
			Weighted Unit Average Canopy Cover		**49%**
39 NDF, UB	32	5	32	**72%**	**71%**
46 P, M, UB	621	4 (UB only)	47	**51%**	46%
		5	431		41%
		6	105		41%
		7	38		41%
			Weighted Unit Average Canopy Cover		**41%**
47 P, UB	33	5	33	**51%**	**46%**
61 NDF, H, PB, UB	20	1	15	**74%**	64%
		2	5		64%
			Weighted Unit Average Canopy Cover		**64%**
73 NDF, M, UB	144	4	6	**72%**	52%
		5	107		51%
		6	27		49%
		7	4		47%
			Weighted Unit Average Canopy Cover		**51%**
76 YF, M, UB	91	4 (UB only)	4	**56%**	53%
		5	37		43%
		6	42		43%
		7	8		43%
			Unit Average Canopy Cover		**43%**
80 A	5	8	5	n/a	n/a
85 NDF, M	64	5	10	62%	53%
		6	53		54%
		8	1	n/a	n/a

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Canopy Cover	Predicted Residual Canopy Cover
			Weighted Unit Average Canopy Cover	**62%**	**54%**
87 P, M	207	5	67	**60%**	46%
		6	130		46%
		7	10		46%
			Weighted Unit Average Canopy Cover		**46%**
89 NDF, M, UB	34	4	6	**80%**	58%
		6	28		56%
			Weighted Unit Average Canopy Cover		**56%**
90 NDF, M, UB	40	6	40	**78%**	**51%**
91 NDF, H, PB	9	2	9	**62%**	**58%**
98 YF, H, PB	63	1	43	**57%**	40%
		2	9		40%
		5	11		40%
			Weighted Unit Average Canopy Cover		**40%**
99 YF, H, PB	67	1	7	**59%**	64%
		2	4		64%
		4	11		64%
		5 (M only)	37		63%
		6 (M only)	8		63%
			Weighted Unit Average Canopy Cover		**63%**
100 NDF, H, PB, UB	120	1	14	**64%**	61%
		2	19		61%
		4	17		61%
		5	46		59%
		6	24		59%
			Weighted Unit Average Canopy Cover		**60%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Canopy Cover	Predicted Residual Canopy Cover
156 **NDF, M, PB**	84	1	84	**75%**	**54%**
163 **NDF, M, PB, UB**	82	1	29	**66%**	50%
		5	49		50%
		7	4		54%
			Weighted Unit Average Canopy Cover		**50%**
213 **NDF, M, PB**	268	1	182	**68%**	57%
		2	11		51%
		4	21		50%
		5	18		51%
		6	25		50%
		7	11		49%
			Weighted Unit Average Canopy Cover		**55%**
282 **NDF, H, PB, UB**	108	2	46	**76%**	56%
		6	62		61%
			Weighted Unit Average Canopy Cover		**59%**
Totals			**Total Weighted Unit Average Canopy Cover**	**63%**	**48%**

Alternative 1 prescriptions reduce canopy cover by approximately 15%. Although different units may have unique canopy cover requirements, set forth by the Forest Plan, all units would remain within Forest Plan standards and guidelines for canopy cover retention. For example, units that overlap a California Spotted Owl Home Range Core Area, such as unit 213, would maintain at least 50 percent canopy cover, consistent with Forest Plan standards and guidelines. Unit 213 treatments were therefore prescribed to retain 55 percent canopy cover. Not only do Alternative 1 prescriptions meet Forest Plan requirements, but canopy cover reduction between trees and groups of trees is expected to free up some available growing space for the remaining trees as well provide opportunities for reproducing more shade intolerant tree species. Further, as described under the variable thinning prescription and emphasis area discussion, ground and topographic conditions dictate where much of the canopy cover reductions would occur. In other words, treatments under Alternative 1 are designed to reduce relatively more canopy cover in areas that would have supported higher amounts of shade intolerant regeneration, but a lower overall tree population under active fire conditions. In areas that would have had a higher composition of shade tolerant species and a larger overall tree population with active fire, Alternative 1 treatments retain higher amounts of canopy cover.

SUMMARY OF DIRECT AND INDIRECT EFFECTS of the Proposed Action (Alternative 1)

The implementation of the proposed action within the Sagehen Project Area would not only meet project goals, but would also improve forest stand conditions immediately after treatment and well into the future. Competition, as revealed in the stand density and canopy cover discussions, would remain at levels that would enhance tree and overall stand resiliency for the next 30 years. Those levels, as shown through mortality calculations however, would not be reduced at the expense of the recruitment of larger dead structures. In fact, the proposed action shows much of the projected mortality occurring in trees greater than 14.9 inches dbh. Although present conditions may be currently producing a reasonable amount of mortality, most of that occurs in trees that are much smaller and may have limited value for long term forest structure. Further, this report discloses the size and amounts of trees that the proposed action would remove. Although there are some instances where trees between 20 inches dbh and 29.9 inches dbh would be slated for removal to meet some project goals, the vast majority of trees to be removed would be in the smaller size classes. This ensures a healthy population of medium and large, resilient trees across much of the Project Area while freeing up available resources for smaller trees to guarantee a replacement population of medium and large trees.

Alternative 2. Effects of the “No Action” Alternative:

The following tables (17-20) show the direct and indirect effects of taking no action in the Sagehen Project’s treatment units after 30 years. The subsequent indirect effects of no action can be traced through changes in average stand conditions over time as shown by stand density, numbers of medium and large trees, tree mortality, and canopy cover. Indirect effects of the No Action Alternative are caused by an increase in inter-tree competition that limits the ability of individual trees to access to light, water, and nutrients. Over time, this results in a reduction in stand resiliency, a continued trend of the majority of the basal area occurring in smaller trees, increased mortality, and reduced levels of mortality in trees greater than 14.9 inches dbh compared to the action alternatives (Alternatives 1 and 3).

In all tables, units have an abbreviation attached to the unit number in order to help orient the reader as to the existing condition of the unit (natural developed forest, natural young forest, plantation and aspen). Existing unit conditions are more fully discussed in the “Affected Environment” section of the report.

Natural developed forest - **NDF**

Natural young forest - **YF**

Plantation - **P**

Aspen - **A**

No Treatment - **NT**

Stand Density:
Table 17 compares both current basal area as well as basal area in 30 years after no treatment (predicted using FVS – South Central Oregon Northern California).

Table 17: Alternative 2: Basal Area – Existing Conditions and 30 Years after No Action

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	30 year Predicted Basal Area (sq. ft./ac.)
33 NDF, NT	118	1	4	**255**	**305**
		4	30		
		5	28		
		6	56		
34 NDF, NT	68	5	16	**218**	**278**
		6	47		
		7	5		
35 NDF, NT	64	1	8	**238**	**294**
		4	6		
		5	7		
		6	37		
		7	6		
36 NDF, NT	101	4	18	**264**	**305**
		5	13		
		6	56		
		7	14		
38 NDF, NT	210	1	67	**223**	**311**
		4	7		
		5	86		
		7	50		
39 NDF, NT	32	5	32	**235**	**340**
46 P, NT	621	4	47	**104**	**172**
		5	431		
		6	105		
		7	38		
47 P, NT	33	5	33	**104**	**172**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	30 year Predicted Basal Area (sq. ft./ac.)
61 **NDF, NT**	20	1	15	**250**	**277**
		2	5		
73 **NDF, NT**	144	4	6	**252**	**321**
		5	107		
		6	27		
		7	4		
76 **YF, NT**	91	4	4	**136**	**225**
		5	37		
		6	42		
		7	8		
80 **A, NT**	5	8	5	**n/a**	**n/a**
85 **NDF, NT**	64	5	10	**208**	**195**
		6	53		
		8	1		
87 **P, NT**	207	5	67	**127**	**215**
		6	130		
		7	10		
89 **NDF, NT**	34	4	6	**251**	**250**
		6	28		
90 **NDF, NT**	40	6	40	**272**	**304**
91 **NDF, NT**	9	2	9	**188**	**214**
98 **NDF, NT**	63	1	43	**143**	**261**
		2	9		
		5	11		
99 **NDF, NT**	67	1	7	**144**	**203**
		2	4		
		4	11		
		5	37		
		6	8		
100 **NDF, NT**	120	1	14	**204**	**264**
		2	19		
		4	17		
		5	46		
		6	24		
156 **NDF, NT**	84	1	84	**290**	**354**
163 **NDF, NT**	82	1	29	**227**	**304**
		5	49		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	30 year Predicted Basal Area (sq. ft./ac.)
		7	4		
213 **NDF, NT**	268	1	182	**292**	**349**
		2	11		
		4	21		
		5	18		
		6	25		
		7	11		
282 **NDF, NT**	108	2	46	**278**	**278**
		6	62		
Totals			**Total Weighted Unit Average Basal Area**	**196**	**259**

Table 17 shows the increase in basal area 30 years from 2011. On weighted average, the basal area would increase by about 63 over the Project Area under the No Action Alternative. FVS modeling shows many units beginning to exceed a basal area of 300 square feet per acre after 30 years. Although portions of stands may be able to support pockets of this level of density, basal areas exceeding 300 square feet per acre across a stand of trees is most likely not consistent with basal area levels that would have developed under active fire conditions, and these consistently higher levels of basal area would be expected to put the entire stand at a greater risk of a stand replacing disturbance.

Table 18 displays the distribution of basal area in medium- and large-sized trees (greater than 19.9 inches dbh) after 30 years under the No Action Alternative.

Table 18: Alternative 2: Percentage of Basal Area in Trees greater than 19.9 inches dbh – 30 Years after No Action

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees greater than 19.9 inches dbh	Predicted % of Basal Area in Trees greater than 19.9 inches dbh in 30 years
33 **NDF, NT**	118	1	4	**41%**	**62%**
		4	30		
		5	28		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees greater than 19.9 inches dbh	Predicted % of Basal Area in Trees greater than 19.9 inches dbh in 30 years
		6	56		
34 NDF, NT	68	5	16	**34%**	**49%**
		6	47		
		7	5		
35 NDF, NT	64	1	8	**47%**	**58%**
		4	6		
		5	7		
		6	37		
		7	6		
36 NDF, NT	101	4	18	**31%**	**57%**
		5	13		
		6	56		
		7	14		
38 NDF, NT	210	1	67	**41%**	**61%**
		4	7		
		5	86		
		7	50		
39 NDF, NT	32	5	32	**16%**	**46%**
46 P, NT	621	4	47	**4%**	**10%**
		5	431		
		6	105		
		7	38		
47 P, NT	33	5	33	**4%**	**10%**
61 NDF, NT	20	1	15	**17%**	**45%**
		2	5		
73 NDF, NT	144	4	6	**42%**	**58%**
		5	107		
		6	27		
		7	4		
76 YF, NT	91	4	4	**35%**	**42%**
		5	37		
		6	42		
		7	8		
80 A, NT	5	8	5	**n/a**	**n/a**
85	64	5	10	**43%**	**61%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees greater than 19.9 inches dbh	Predicted % of Basal Area in Trees greater than 19.9 inches dbh in 30 years
NDF, NT		6	53		
		8	1		
87 P, NT	207	5	67	**0%**	**0%**
		6	130		
		7	10		
89 NDF, NT	34	4	6	**14%**	**39%**
		6	28		
90 NDF, NT	40	6	40	**29%**	**50%**
91 NDF, NT	9	2	9	**34%**	**68%**
98 NDF, NT	63	1	43	**22%**	**36%**
		2	9		
		5	11		
99 NDF, NT	67	1	7	**0%**	**8%**
		2	4		
		4	11		
		5	37		
		6	8		
100 NDF, NT	120	1	14	**56%**	**61%**
		2	19		
		4	17		
		5	46		
		6	24		
156 NDF, NT	84	1	84	**33%**	**54%**
163 NDF, NT	82	1	29	**48%**	**61%**
		5	49		
		7	4		
213 NDF, NT	268	1	182	**45%**	**70%**
		2	11		
		4	21		
		5	18		
		6	25		
		7	11		
282 NDF, NT	108	2	46	**44%**	**68%**
		6	62		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees greater than 19.9 inches dbh	Predicted % of Basal Area in Trees greater than 19.9 inches dbh in 30 years
Totals			**Total Unit Weighted Average % of Basal Area in Trees greater than 19.9 inches dbh**	**27%**	**40%**

After 30 years, the No Action Alternative would leave the majority of the basal area in the Sagehen Project Area treatment units in trees less than 20 inches dbh. High basal areas in many units, combined with a larger portion of that basal area residing in smaller trees, would create a high stress environment where many trees would be competing for a limited amount of resources.

Medium and Large Trees

Table 18 above also shows how the diameters of trees (particularly medium and large trees – greater than 19.9 inches dbh) are distributed after 30 years of no action. The majority of the Project Area's treatment unit basal areas would remain in trees less than 20 inches dbh. The reverse-J diameter distribution (stands comprised of large numbers of small trees and relatively few large-diameter trees) would generally remain intact across the treatment units, and is inconsistent with the diameter distribution that would have developed under active fire conditions.

No larger living trees would be removed under the No Action Alternative. This would ensure that the larger living trees remained on the landscape in the short term; however, as the basal area and mortality discussions for the No Action Alternative explain, it may not ensure their numbers remain on the landscape in the long term. Further, in contrast to Alternative 1, implementation of the No Action Alternative would not allow forest managers to create favorable growing conditions for the larger living trees that would have the best opportunity to survive, nor would managers be able to favor tree species that would be the dominant larger tree replacements.

Tree Mortality

Table 19 shows FVS predictions of mortality in 30 years under the No Action Alternative.

Table 19: Alternative 2: Annual Mortality Rate – Existing Condition and 30 Years after No Action

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality	No Action 30 year Predicted % of Mortality
33 NDF, NT	118	1	4	**0.53%**	**1.07%**
		4	30		
		5	28		
		6	56		
34 NDF, NT	68	5	16	**0.52%**	**1.02%**
		6	47		
		7	5		
35 NDF, NT	64	1	8	**0.50%**	**0.93%**
		4	6		
		5	7		
		6	37		
		7	6		
36 NDF, NT	101	4	18	**0.51%**	**1.08%**
		5	13		
		6	56		
		7	14		
38 NDF, NT	210	1	67	**0.15%**	**0.40%**
		4	7		
		5	86		
		7	50		
39 NDF, NT	32	5	32	**0.66%**	**1.25%**
46 P, NT	621	4	47	**0.07%**	**0.59%**
		5	431		
		6	105		
		7	38		
47 P, NT	33	5	33	**0.07%**	**0.59%**
61	20	1	15	**0.54%**	**1.25%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality	No Action 30 year Predicted % of Mortality
NDF, NT		2	5		
73 NDF, NT	144	4	6	**0.46%**	**0.97%**
		5	107		
		6	27		
		7	4		
76 YF, NT	91	4	4	**0.07%**	**0.38%**
		5	37		
		6	42		
		7	8		
80 A, NT	5	8	5	**n/a**	**n/a**
85 NDF, NT	64	5	10	**0.12%**	**0.40%**
		6	53		
		8	1		
87 P, NT	207	5	67	**0.12%**	**0.54%**
		6	130		
		7	10		
89 NDF, NT	34	4	6	**1.79%**	**1.18%**
		6	28		
90 NDF, NT	40	6	40	**0.48%**	**1.11%**
91 NDF, NT	9	2	9	**0.77%**	**1.18%**
98 NDF, NT	63	1	43	**0.10%**	**1.44%**
		2	9		
		5	11		
99 NDF, NT	67	1	7	**1.36%**	**1.76%**
		2	4		
		4	11		
		5	37		
		6	8		
100 NDF, NT	120	1	14	**0.37%**	**0.30%**
		2	19		
		4	17		
		5	46		
		6	24		
156 NDF, NT	84	1	84	**0.50%**	**1.18%**
163 NDF, NT	82	1	29	**0.67%**	**1.12%**
		5	49		
		7	4		
213	268	1	182	**0.59%**	**1.12%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality	No Action 30 year Predicted % of Mortality
NDF, NT		2	11		
		4	21		
		5	18		
		6	25		
		7	11		
282 NDF, NT	108	2	46	**1.09%**	**0.81%**
		6	62		
Totals			**Total Weighted Average % of Mortality**	**0.38%**	**0.80%**

The predicted annual mortality rate in 30 years after no treatments were implemented in the Sagehen Project area is about 0.80 percent (weighted average) across the project. This number is not only much higher than the SSPM mortality rate, but even higher than Plumas National Forest study at 0.6 percent. Using the example from above, a 200-acre stand with 300 trees per acre would lose as many as 480 trees annually to resource stress alone, which is well over two trees per acre per year. Trees would have trouble reaching ages above 130 years and would most likely not acquire old growth characteristics. It is known, however, that mortality rates are rarely constant and difficult to forecast where mortality might occur. Therefore, this scenario is designed to simply illustrate what that mortality rate may mean for a stand of trees over time and is not aimed at predicting a persistent mortality rate nor where that mortality might occur. Further, because many trees are dying at young ages, larger dead structures (snags) would be a smaller percentage of the mortality as shown in Table 20.

Table 20: Alternative 2: Percentage of All Trees Expected to die on an Annual Basis that are Greater than 14.9 inches dbh – 30 Years after No Action

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
33 NDF, NT	118	1	4	**8%**	**31%**
		4	30		
		5	28		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
		6	56		
34 **NDF, NT**	68	5	16	**11%**	**32%**
		6	47		
		7	5		
35 **NDF, NT**	64	1	8	**9%**	**31%**
		4	6		
		5	7		
		6	37		
		7	6		
36 **NDF, NT**	101	4	18	**5%**	**29%**
		5	13		
		6	56		
		7	14		
38 **NDF, NT**	210	1	67	**14%**	**45%**
		4	7		
		5	86		
		7	50		
39 **NDF, NT**	32	5	32	**4%**	**17%**
46 **P, NT**	621	4	47	**0%**	**15%**
		5	431		
		6	105		
		7	38		
47 **P, NT**	33	5	33	**0%**	**15%**
61 **NDF, NT**	20	1	15	**2%**	**28%**
		2	5		
73 **NDF, NT**	144	4	6	**8%**	**23%**
		5	107		
		6	27		
		7	4		
76 **YF, NT**	91	4	4	**2%**	**13%**
		5	37		
		6	42		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
		7	8		
80 A, NT	5	8	5	**n/a**	**n/a**
85 NDF, NT	64	5	10	**11%**	**36%**
		6	53		
		8	1	**n/a**	**n/a**
87 P, NT	207	5	67	**0%**	**12%**
		6	130		
		7	10		
89 NDF, NT	34	4	6	**2%**	**27%**
		6	28		
90 NDF, NT	40	6	40	**5%**	**29%**
91 NDF, NT	9	2	9	**16%**	**68%**
98 NDF, NT	63	1	43	**2%**	**12%**
		2	9		
		5	11		
99 NDF, NT	67	1	7	**0%**	**34%**
		2	4		
		4	11		
		5	37		
		6	8		
100 NDF, NT	120	1	14	**13%**	**30%**
		2	19		
		4	17		
		5	46		
		6	24		
156 NDF, NT	84	1	84	**5%**	**22%**
163 NDF, NT	82	1	29	**10%**	**32%**
		5	49		
		7	4		
213 NDF, NT	268	1	182	**12%**	**39%**
		2	11		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
		4	21		
		5	18		
		6	25		
		7	11		
282 NDF, NT	108	2	46	**15%**	**42%**
		6	62		
Totals			**Total Weighted Average % of Mortality in Trees greater than 14.9 inches dbh**	**6%**	**26%**

After 30 years of no action, the weighted average annual percent of trees greater than 14.9 inches dbh expected to die only increases to 26 percent in 30 years. This means that in 30 years, only a quarter of all the trees drying will be in trees over 14.9 inches dbh. Therefore as shown in table 14, although mortality rates continue to increase over time, that mortality, as shown in table 15, is minimally concentrated in trees greater than 14.9 inches dbh. Although a certain amount of smaller dead material is desirable for nutrient cycling and other project goals, this amount exceeds levels that would have developed with active fire conditions under an active fire regime. Further, although FVS does predict an increase over time in the larger (greater than 14.9 inches) snag population, it is accompanied with high annual mortality rates and potentially an unsustainable loss of medium and large (greater than 19.9 inches) living trees essential to resilient stands and an inherent element of other project goals. In other words, a healthy Sierra Nevada forest is believed to require a robust medium and large tree cycle that depends on a vigorous replacement population, a resilient current population, and sustainable amounts of mortality from larger trees that perish due to old age and not resource stress. The No Action Alternative, as shown in this discussion, moderates this medium and large tree cycle.

Canopy Cover:
Canopy cover would be unaltered under the No Action Alternative and would be expected to increase over time. Although this increase over time would benefit some project goals, it would minimize the ability for shade intolerant species to regenerate across the stand. Shade tolerant species would

continue to establish, but the stands would be void of unencumbered early and mid seral shade intolerant trees and therefore the future replacement of the stands larger (greater than 19.9 inches dbh) shade intolerant population would most likely be by larger shade tolerant trees. These shade tolerant trees are somewhat less resilient to disturbance, and although have value in certain numbers, the species overabundance would exacerbate many forest disturbances and decrease the overall stand resiliency.

SUMMARY OF DIRECT AND INDIRECT EFFECTS of the No Action Alternative (Alternative 2)

The direct and indirect effects of the No Action Alternative would maintain and perpetuate homogenous conditions, which would leave the Project Area susceptible to uncharacteristically large scale disturbances in what has historically been a heterogeneous forest affected by smaller and varied disturbances. Competition would increase among all trees and stress induced mortality would be unpredictable and occur in undesirable size classes. The shift in shade tolerant tree species would continue as increasing canopy cover limited the ability for shade intolerant species to regenerate.

Alternative 3. Effects of the "Non Commercial Funding" Alternative:

The following tables (21-24) show the direct and indirect effects of treatments in the change from current condition to the immediate post treatment condition in some instances and 30 years post treatment in others.   The subsequent indirect effects of the treatments can be traced through changes in average stand conditions over time as shown by stand density, numbers of medium and large trees, tree mortality, and canopy cover. Indirect effects of the "Non Commercial Funding" Alternative are caused by the reduction in inter-tree competition that would permit individual trees greater access to light, water, and nutrients in the treated units.   Over time, this would result in an observable growth response for height and diameter, especially in smaller diameter classes that have been released from competition from nearby brush and trees in those units that were treated. Since the areas that were treated would have improved growing conditions, overall resistance to environmental stress, including insect attack, drought, or disease, would improve. However, given the limited extent of treatments under Alternative 3, the majority of the stands in the Sagehen Project Area would remain in a trajectory that is inconsistent with a fire regime one landscape with active fire conditions, making the area at higher risk to large scale disturbance and high mortalities from inter-tree competition in the future (30 years).

In all tables, units have an abbreviation attached to the unit number in order to help orient the reader as to the condition of the unit (natural developed forest, natural young forest, plantation and aspen) as well as the silviculture and fuels treatment method that would be used (mechanical, hand, pile burn, underburn and no treatment). Existing unit conditions are more fully discussed in the "Affected Environment" section of the report while the silviculture and fuels treatment methods are thoroughly defined under each alternative's "Prescription and Treatment Method Definitions" section of the report.

Natural developed forest - **NDF**

Natural young forest - **YF**

Plantation - **P**

Aspen - **A**

Mechanical - **M**

Hand - **H**

Pile burn - **PB**

Underburn - **UB**

No Treatment - **NT**

Stand Density

Table 21 displays existing basal area as well as immediate post-treatment residual basal area and basal area 30 years after treatment under Alternative 3. Note that, while Table 21 displays all the treatment units, only those proposed for treatment under Alternative 3 show a change in residual basal area. Those units not proposed for treatment under Alternative 3 are identified with "NT" and show no change between current and residual basal area.

Table 21: Alternative 3: Basal Area: Existing Condition, Post- treatment, and 30 Years After Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (sq. ft./ac.)	30 year Predicted Basal Area (sq. ft./ac.)
33 NDF, NT	118	1	4	**255**	**255**	**305**
		4	30			
		5	28			
		6	56			
34 NDF, NT	68	5	16	**218**	**218**	**278**
		6	47			
		7	5			
35 NDF, NT	64	1	8	**238**	**238**	**294**
		4	6			
		5	7			
		6	37			
		7	6			
36 NDF, NT	101	4	18	**264**	**264**	**305**
		5	13			
		6	56			
		7	14			
38 NDF, NT	210	1	67	**223**	**223**	**311**
		4	7			

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (sq. ft./ac.)	30 year Predicted Basal Area (sq. ft./ac.)
		5	86			
		7	50			
39 NDF, NT	32	5	32	**235**	**235**	**340**
46 P, M, UB	621	4 (UB only)	47	**104**	**81**	**141**
		5	431			
		6	105			
		7	38			
47 P, UB	33	5	33	**104**	**93**	**169**
61 NDF, H, PB, UB	20	1	15	**250**	**174**	**255**
		2	5			
73 NDF, NT	144	4	6	**252**	**252**	**321**
		5	107			
		6	27			
		7	4			
76 YF, M, UB	91	4 (UB only)	4	**136**	**104**	**165**
		5	37			
		6	42			
		7	8			
80 A, NT	5	8	5	**n/a**	**n/a**	**n/a**
85 NDF, NT	64	5	10	**208**	**208**	**195**
		6	53			
		8	1			
87 P, NT	207	5	67	**127**	**127**	**215**
		6	130			
		7	10			
89 NDF, NT	34	4	6	**251**	**251**	**250**
		6	28			
90 NDF, NT	40	6	40	**272**	**272**	**304**
91 NDF, H, PB	9	2	9	**188**	**171**	**215**
98 YF, H, PB	63	1	43	**143**	**126**	**232**
		2	9			
		5	11			
99 YF, M, H, PB	67	1	7	**144**	**115**	**200**
		2	4			
		4	11			
		5 (M only)	37			

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Basal Area (sq. ft./ac.)	Residual Basal Area (sq. ft./ac.)	30 year Predicted Basal Area (sq. ft./ac.)
		6 (M only)	8			
100 NDF, H, PB, UB	120	1	14	**204**	**165**	**209**
		2	19			
		4	17			
		5	46			
		6	24			
156 NDF, NT	84	1	84	**290**	**290**	**354**
163 NDF, NT	82	1	29	**227**	**227**	**304**
		5	49			
		7	4			
213 NDF, NT	268	1	182	**292**	**292**	**349**
		2	11			
		4	21			
		5	18			
		6	25			
		7	11			
282 NDF, H, PB, UB	108	2	46	**278**	**195**	**238**
		6	62			
Totals			**Total Weighted Unit Average Basal Area**	**196**	**182**	**244**

Table 21 shows the reduction in basal area in the units proposed for the fuels focused treatments under Alternative 3. This reduction in basal area would only help reduce associated density related stresses on the residual trees post treatment in the units proposed for treatment under this alternative. This table also shows the basal area predicted in 30 years under implementation of Alternative 3. Over the Sagehen Project Area treatment units, the post-treatment basal area shows Alternative 3's minimal effects on reducing stand density (weighted average of approximately 10 square feet per acre basal area reduction) because the majority of units would not be treated under this alternative. Many units would begin to exceed a basal area of 300 square feet per acre after 30 years. Although portions of stands might be able to support pockets of this level of stand density, a basal area of greater than 300 square feet per acre across a stand of trees is most likely not consistent with stand densities that would have developed under active fire conditions and would likely put the entire stand at a greater risk of a stand replacing disturbance.

Further, under Alternative 3, much of the basal area is composed of smaller trees as shown in Table 22. While Table 22 displays all the treatment units, only those proposed for treatment under Alternative 3 reflect the effects of the hazardous fuels reduction treatments proposed under this alternative on basal area in trees greater than 19.9 inches dbh. The predictions for the units not proposed for treatment under Alternative 3 (identified with "NT" in Table 22) are the same as those projected under the No Action Alternative.

Table 22: Alternative 3: Percentage of Basal Area in Trees greater than 19.9 inches dbh – Existing Conditions and 30 Years after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees greater than 19.9 inches dbh	Predicted % of Basal Area in Trees greater than 19.9 inches dbh in 30 years
33 **NDF, NT**	118	1	4	**41%**	**62%**
		4	30		
		5	28		
		6	56		
34 **NDF, NT**	68	5	16	**34%**	**49%**
		6	47		
		7	5		
35 **NDF, NT**	64	1	8	**47%**	**58%**
		4	6		
		5	7		
		6	37		
		7	6		
36 **NDF, NT**	101	4	18	**31%**	**57%**
		5	13		
		6	56		
		7	14		
38 **NDF, NT**	210	1	67	**41%**	**61%**
		4	7		
		5	86		
		7	50		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees greater than 19.9 inches dbh	Predicted % of Basal Area in Trees greater than 19.9 inches dbh in 30 years
39 NDF, NT	32	5	32	**16%**	**46%**
46 P, M, UB	621	4 (UB only)	47	**4%**	**17%**
		5	431		
		6	105		
		7	38		
47 P, UB	33	5	33	**4%**	**11%**
61 NDF, H, PB, UB	20	1	15	**17%**	**48%**
		2	5		
73 NDF, NT	144	4	6	**42%**	**58%**
		5	107		
		6	27		
		7	4		
76 YF, M, UB	91	4 (UB only)	4	**35%**	**54%**
		5	37		
		6	42		
		7	8		
80 A, NT	5	8	5	**n/a**	**n/a**
85 NDF, NT	64	5	10	**43%**	**61%**
		6	53		
		8	1	**n/a**	**n/a**
87 P, NT	207	5	67	**0%**	**0%**
		6	130		
		7	10		
89 NDF, NT	34	4	6	**14%**	**39%**
		6	28		
90 NDF, NT	40	6	40	**29%**	**50%**
91 NDF, H, PB	9	2	9	**34%**	**69%**
98 YF, H, PB	63	1	43	**22%**	**40%**
		2	9		
		5	11		
99 YF, M, H, PB	67	1	7	**1%**	**6%**
		2	4		
		4	11		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Basal Area in Trees greater than 19.9 inches dbh	Predicted % of Basal Area in Trees greater than 19.9 inches dbh in 30 years
		5 (M only)	37		
		6 (M only)	8		
100 **NDF, H, PB, UB**	120	1	14	**56%**	**76%**
		2	19		
		4	17		
		5	46		
		6	24		
156 **NDF, NT**	84	1	84	**33%**	**54%**
163 **NDF, NT**	82	1	29	**48%**	**61%**
		5	49		
		7	4		
213 **NDF, NT**	268	1	182	**45%**	**70%**
		2	11		
		4	21		
		5	18		
		6	25		
		7	11		
282 **NDF, H, PB, UB**	108	2	46	**44%**	**90%**
		6	62		
Totals			**Total Unit Weighted Average % of Basal Area in Trees greater than 19.9 inches dbh**	**27%**	**44%**

After 30 years, units that would receive treatment under Alternative 3 show 15%-25% more basal area in medium to large trees than units with no treatment. This increases the overall project weighted average percentage of basal area in trees greater than 19.9 inches dbh over the No Action Alternative, but leaves units that would not be treated with continued high amounts of their basal area in smaller trees, even after 30 years. This would most likely produce unsustainable amounts of mortality in those units as shown in Table 23.

Medium and Large Trees

Table 22 above displays how the stand basal area, specifically in medium and large trees – greater than 19.9 inches dbh, would be distributed 30 years post treatment in Alternative 3. The majority of Project Area's unit basal areas would remain in trees less than 20 inches dbh. The reverse-J diameter distribution (stands comprised of large numbers of small trees and relatively few large-diameter trees) would generally remain intact and is inconsistent with diameter distributions that would have developed under active fire conditions.

Generally, trees less than 12 inches dbh (with occasional trees between 12 and 18 inches dbh in the plantations) would be removed under the "Non Commercial Funding" Alternative. This would ensure that the larger living trees remain on the landscape in the short term, but might not ensure their numbers remain on the landscape in the long term. Further, in contrast to Alternative 1, implementation of Alternative 3 would not allow forest managers to create favorable growing conditions for the larger living trees that would have the best opportunity to survive, nor would managers be able to favor tree species that would be the dominant larger tree replacements.

Tree Mortality

Table 23 shows current mortality rates and predicted mortality rates 30 years after treatment under Alternative 3. While Table 23 (and Table 24 below) displays all the treatment units, only those proposed for treatment under Alternative 3 reflect the effects of the hazardous fuels reduction treatments proposed under this alternative on annual mortality rates. The predictions for the units not proposed for treatment under Alternative 3 (identified with "NT" in Table 23) are the same as those projected under the No Action Alternative.

Table 23: Alternative 3: Annual Mortality Rate – Existing Condition and 30 Years after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality	30 year Predicted % of Mortality
33 NDF, NT	118	1	4	**0.53%**	**1.07%**
		4	30		
		5	28		
		6	56		
34 NDF, NT	68	5	16	**0.52%**	**1.02%**
		6	47		
		7	5		
35 NDF, NT	64	1	8	**0.50%**	**0.93%**
		4	6		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality	30 year Predicted % of Mortality
		5	7		
		6	37		
		7	6		
36 **NDF, NT**	101	4	18	**0.51%**	**1.08%**
		5	13		
		6	56		
		7	14		
38 **NDF, NT**	210	1	67	**0.15%**	**0.40%**
		4	7		
		5	86		
		7	50		
39 **NDF, NT**	32	5	32	**0.66%**	**1.25%**
46 **P, M, UB**	621	4 (UB only)	47	**0.07%**	**0.16%**
		5	431		
		6	105		
		7	38		
47 **P, UB**	33	5	33	**0.07%**	**0.13%**
61 **NDF, H, PB, UB**	20	1	15	**0.54%**	**0.49%**
		2	5		
73 **NDF, NT**	144	4	6	**0.46%**	**0.97%**
		5	107		
		6	27		
		7	4		
76 **YF, M, UB**	91	4 (UB only)	4	**0.07%**	**0.10%**
		5	37		
		6	42		
		7	8		
80 **A, NT**	5	8	5	**n/a**	**n/a**
85 **NDF, NT**	64	5	10	**0.12%**	**0.40%**
		6	53		
		8	1	**n/a**	**n/a**
87 **P, NT**	207	5	67	**0.12%**	**0.54%**
		6	130		
		7	10		
89 **NDF, NT**	34	4	6	**1.79%**	**1.18%**
		6	28		
90 **NDF, NT**	40	6	40	**0.48%**	**1.11%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Mortality	30 year Predicted % of Mortality
91 NDF,H,PB	9	2	9	**0.77%**	**1.17%**
98 YF, H, PB	63	1	43	**0.10%**	**0.54%**
		2	9		
		5	11		
99 YF, M, H, PB	67	1	7	**1.36%**	**1.04%**
		2	4		
		4	11		
		5 (M only)	37		
		6 (M only)	8		
100 NDF, H, PB, UB	120	1	14	**0.37%**	**0.12%**
		2	19		
		4	17		
		5	46		
		6	24		
156 NDF, NT	84	1	84	**0.50%**	**1.18%**
163 NDF, NT	82	1	29	**0.67%**	**1.12%**
		5	49		
		7	4		
213 NDF, NT	268	1	182	**0.59%**	**1.12%**
		2	11		
		4	21		
		5	18		
		6	25		
		7	11		
282 NDF, H, PB, UB	108	2	46	**1.09%**	**0.24%**
		6	62		
Totals			**Total Weighted Average % of Mortality**	**0.38%**	**0.61%**

Mortality weighted average across the Sagehen Project Area treatment units would be approximately 0.50 percent 30 years after the "Non Commercial Funding" Alternative's treatments (averaging units 46, 47, 61, 76, 91, 98, 99, 100, 282). While lower than the annual mortality rates under the No Action Alternative, this number is still quite high; however, even more concerning is the mortality percentage in many of the stands that would not be treated under this alternative. Averaging, by weight, those stands with the treated stands equates to a 0.61 percent mortality rate. This, as discussed in previous alternatives, is an unsustainable amount of mortality in these units and they would be challenged to resist large scale disturbance. The treated units would most likely help alleviate and constrain stress induced disturbance across the Project Area, but probably not large enough to substantially alter its progression. Further, as displayed in Table 24, the majority of the mortality remains in smaller trees across the Project Area's treatment units even after 30 years and even larger percentages would occur in stands not treated under this alternative.

Table 24: Alternative 3: Percentage of All Trees Expected to die on an Annual Basis that are Greater than 14.9 inches dbh – 30 Years after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
33 NDF, NT	118	1	4	**8%**	**31%**
		4	30		
		5	28		
		6	56		
34 NDF, NT	68	5	16	**11%**	**32%**
		6	47		
		7	5		
35 NDF, NT	64	1	8	**9%**	**31%**
		4	6		
		5	7		
		6	37		
		7	6		
36 NDF, NT	101	4	18	**5%**	**29%**
		5	13		
		6	56		
		7	14		
38 NDF, NT	210	1	67	**14%**	**45%**
		4	7		
		5	86		
		7	50		
39 NDF, NT	32	5	32	**4%**	**17%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
46 **P, M, UB**	621	4 (UB only)	47	**0%**	**45%**
		5	431		
		6	105		
		7	38		
47 **P, UB**	33	5	33	**0%**	**21%**
61 **NDF, H, PB, UB**	20	1	15	**2%**	**27%**
		2	5		
73 **NDF, NT**	144	4	6	**8%**	**23%**
		5	107		
		6	27		
		7	4		
76 **YF, M, UB**	91	4 (UB only)	4	**2%**	**21%**
		5	37		
		6	42		
		7	8		
80 **A, NT**	5	8	5	**n/a**	**n/a**
85 **NDF, NT**	64	5	10	**11%**	**36%**
		6	53		
		8	1	**n/a**	**n/a**
87 **P, NT**	207	5	67	**0%**	**12%**
		6	130		
		7	10		
89 **NDF, NT**	34	4	6	**2%**	**27%**
		6	28		
90 **NDF, NT**	40	6	40	**5%**	**29%**
91 **NDF, H, PB**	9	2	9	**16%**	**68%**
98 **YF, H, PB**	63	1	43	**2%**	**14%**
		2	9		
		5	11		
99 **YF, M, H, PB**	67	1	7	**1%**	**27%**
		2	4		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current % of Trees Greater than 14.9 inches dbh Expected to die on an Annual Basis	Predicted % of all Trees Expected to die on an Annual Basis after 30 years that are Greater than 14.9 inches dbh
		4	11		
		5 (M only)	37		
		6 (M only)	8		
100 NDF, H, PB, UB	120	1	14	**13%**	**50%**
		2	19		
		4	17		
		5	46		
		6	24		
156 NDF, NT	84	1	84	**5%**	**22%**
163 NDF, NT	82	1	29	**10%**	**32%**
		5	49		
		7	4		
213 NDF, NT	268	1	182	**12%**	**39%**
		2	11		
		4	21		
		5	18		
		6	25		
		7	11		
282 NDF, H, PB, UB	108	2	46	**15%**	**81%**
		6	62		
Totals			**Total Weighted Average % of Mortality in Trees greater than 14.9 inches dbh**	**6%**	**36%**

Treatments are predicted to increase the weighted average annual percent of trees greater than 14.9 inches dbh expected to die by 30 percent in 30 years. In other words, of all the trees in the Project Area that are projected to die in the 30th year after Alternative 3 treatments are completed, only 36 percent of those trees are larger than 14.9 inches. Therefore as shown in table 23, mortality rates not only increase over time, but that mortality, as shown in table 24, is still mostly concentrated in trees less than 15 inches dbh. This trend is still not consistent with conditions associated with a forest ecosystem that experienced active fire under an active fire regime.

Canopy Cover:

Table 25 compares predicted residual canopy cover under Alternative 3 with current conditions. Note that, while Table 25 displays all the treatment units, only those proposed for treatment under Alternative 3 show a change in residual canopy cover. Those units not proposed for treatment under Alternative 3 are identified with "NT" and show no change between current and residual canopy cover.

Table 25: Alternative 3: Canopy Cover before and after Treatment

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Canopy Cover	Predicted Residual Canopy Cover
33 NDF, NT	118	1	4	**71%**	**71%**
		4	30		
		5	28		
		6	56		
34 NDF, NT	68	5	16	**70%**	**70%**
		6	47		
		7	5		
35 NDF, NT	64	1	8	**68%**	**68%**
		4	6		
		5	7		
		6	37		
		7	6		
36 NDF, NT	101	4	18	**75%**	**75%**
		5	13		
		6	56		
		7	14		
38 NDF, NT	210	1	67	**63%**	**63%**
		4	7		
		5	86		
		7	50		

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Canopy Cover	Predicted Residual Canopy Cover
39 **NDF, NT**	32	5	32	**72%**	**72%**
46 **P, M, UB**	621	4 (UB only)	47	**51%**	**41%**
		5	431		
		6	105		
		7	38		
47 **P, UB**	33	5	33	**51%**	**46%**
61 **NDF, H, PB, UB**	20	1	15	**74%**	**64%**
		2	5		
73 **NDF, NT**	144	4	6	**72%**	**72%**
		5	107		
		6	27		
		7	4		
76 **YF, M, UB**	91	4 (UB only)	4	**56%**	**43%**
		5	37		
		6	42		
		7	8		
80 **A, NT**	5	8	5	n/a	n/a
85 **NDF, NT**	64	5	10	**62%**	**62%**
		6	53		
		8	1	**n/a**	**n/a**
87 **P, NT**	207	5	67	**60%**	**60%**
		6	130		
		7	10		
89 **NDF, NT**	34	4	6	**80%**	**80%**
		6	28		
90 **NDF, NT**	40	6	40	**78%**	**78%**
91 **NDF, H, PB**	9	2	9	**62%**	**58%**
98 **YF, H, PB**	63	1	43	**59%**	**40%**
		2	9		
		5	11		
99 **YF, M, H, PB**	67	1	7	**59%**	**63%**
		2	4		
		4	11		
		5 (M only)	37		
		6 (M only)	8		
100	120	1	14	**64%**	**60%**

Unit	Total Acres	Emphasis Area	Unit Emphasis Area Acres	Current Canopy Cover	Predicted Residual Canopy Cover
NDF, H, PB, UB		2	19		
		4	17		
		5	46		
		6	24		
156 NDF, NT	84	1	84	**75%**	**75%**
163 NDF, NT	82	1	29	**66%**	**66%**
		5	49		
		7	4		
213 NDF, NT	268	1	182	**68%**	**68%**
		2	11		
		4	21		
		5	18		
		6	25		
		7	11		
282 NDF, H, PB, UB	108	2	46	**76%**	**59%**
		6	62		
Totals			**Total Weighted Unit Average Canopy Cover**	**63%**	**58%**

Canopy cover would be reduced in units receiving treatment under the "Non Commercial Funding" Alternative, but would stay well within Forest Plan requirements. This canopy cover reduction between trees and groups of trees is expected to free up some available growing space for the remaining trees as well provide opportunities for more shade intolerant reproduction. However, Alternative 3 prescriptions do not necessarily take site conditions or topography into account. Therefore, residual stand conditions under Alternative 3 would not be expected to closely reflect conditions that might have existed under more active fire conditions.

Canopy cover would be unaltered in units receiving no treatment. In these areas, canopy cover would continue to increase. Although this increase over time would benefit some project goals, it would minimize the ability for shade intolerant species to regenerate across the stand. Shade tolerant species would continue to establish, but the stand would be void of unencumbered early and mid seral shade intolerant trees and therefore the future replacement of the stands' larger (greater than 19.9 inches dbh) shade intolerant population would most likely be by larger shade tolerant trees. These shade tolerant trees are somewhat less resilient to disturbance, and although they have value in certain numbers, the species overabundance would exacerbate many forest disturbances and decrease overall stand resiliency.

SUMMARY OF DIRECT AND INDIRECT EFFECTS of the "Non Commercial Funding" Alternative (Alternative 3)

The direct and indirect effects of the "Non Commercial Funding" Alternative would maintain and perpetuate homogenous conditions in units that would not be receiving treatment, which would leave the overall Project Area susceptible to uncharacteristically large scale disturbances in what has historically been a heterogeneous forest affected by small and varied disturbances. These untreated areas would see competition increase among all trees and stress induced mortality would be unpredictable and would occur in undesirable size classes. The shift in shade tolerant tree species would continue as increasing canopy cover would limit the ability for shade intolerant species to regenerate. Although some units would receive treatment, which may alleviate some of the indirect effects seen in units without treatment, benefits would primarily be realized within unit boundaries. Because these treatments would be relatively modest in effects and limited in size compared to the proposed action (Alternative 1), the larger effect on the surrounding landscape would be marginal under implementation of Alternative 3.

Variability:

The application of a combination of all or some of the silviculture and fuels prescriptions is, by design, intended to strategically introduce measurable variability at different scales in the Sagehen Project Area, which currently lacks a certain amount of variability that might have existed under active fire conditions. There is no baseline for variability; hence, relative differences in variability between the alternatives are assessed in this analysis.

It is important to look, first, at the site scale for variability. As stated under the methodology section of this report, forest vegetation simulations (FVS) are unable to detect site scale differences of the unique prescriptions and therefore consider data from the two test plots to determine variability change. In order to measure this change, coefficient of variation was calculated for basal area and canopy cover between several sample plots that were measured both pre and post treatment within the two test plots. Tables 26 and 27 show the results.

Table 26: Coefficient of Variation Change between Pre- and Post-Treatment Basal Area and Canopy Cover at a Lower Elevation Site (less than 7,000 feet)

	Site Coefficient of Variation (Post Treatment)	Coefficient of Variation (Current Condition)
Basal Area	35%	26%
Canopy Cover	12%	8%

Table 27: Basal Area and Canopy Cover Coefficient of Variation Change between Pre- and Post-Treatment Basal Area and Canopy Cover at an Upper Elevation Site (greater than 7,000 feet)

	Site Coefficient of Variation (Post Treatment)	Coefficient of Variation (Current Condition)
Basal Area	62%	35%
Canopy Cover	40%	27%

Both of these site examples show a measurable increase in the coefficient of variation (CV) after the treatments. Assuming that the pre-treatment conditions approximate the effects under the No Action Alternative (Alternative 2) and post-treatment conditions approximate the effects under Alternative 1, on average, Alternative 1 would result in a basal area that would have an 18 percent higher coefficient of variation and canopy cover that would have approximately a 9 percent higher coefficient of variation over Alternative 2 metrics.

Measuring coefficient of variation under Alternative 3 for site scale comparisons is impossible because there is no way to utilize the same sample points for two different prescriptions; only comparing current condition and post treatment is possible, which logically translates to Alternative 2 and Alternative 1, respectively. With that said, applying Alternative 3 prescriptions would most likely produce less variable conditions at the site scale than both Alternative 1 and Alternative 2. The sole purpose of Alternative 3 prescriptions is to reduce fuels. Although this would not eliminate variability at the site scale, leaving only the largest, well-spaced trees would maintain more consistent crown cover percentages as well as constant basal areas. Therefore, Alternative 3 would most likely have the least amount of variability of all the alternatives at the site scale, and Alternative 1 would have the most.

It is also important to analyze how this variability is managed. This concept is best applied to Alternative 1 through the prescription narratives discussed in the Prescription and Treatment Method Definition section of this report. Although many prescriptions under Alternative 1 include a variability component, the variable thinning prescription, which is prescribed over more of the project than any other prescription, is the most applicable. The variable thinning discussion describes when, where and how variability is to be introduced and is summarized in the “guidelines” section of the variable thinning prescription:

- Generally favor retention of pines over firs, especially in southerly facing areas and on ridges. In areas of more fir dominance, give retention preference to red fir over white fir. Retained groups of larger trees (described under the bullet below) may include fir trees. Overall the emphasis for retained groups of trees is preserving or enhancing desirable stand structure rather managing for any particular species composition.
- Retain groups of larger trees, generally comprised of five to ten (or more) trees of roughly similar size. Ideally, some of the retained trees should have desirable habitat features, such as forked or broken tops. Remove trees adjacent to these retained groups to improve the overall health and resiliency of the group to drought, insects and disease.
- Where a few (less than five) trees occur together, or where trees are scattered, retain the more vigorous trees by removing subdominant and, in some cases, codominant trees around them to reduce ladder fuels and competition for light, water, and nutrients.
- In areas of greater fir dominance where large trees tend to grow in more of a clumped nature, emphasize retaining clumps, or groups, of generally five to ten trees, and removing trees adjacent to these retained clumps to create small, variably shaped gaps.
- When making site-specific determinations on individual tree removal/retention preferences, vary the choices made so as to increase the variability at the micro-site scale.

Alternative 2, as shown in Tables 26 and 27, does maintain some variability at the site scale, but the variability is random and may not be representative of what would occur under active fire conditions. For example, during Project Area field visits, groups of declining, smaller white fir were discovered on rocky knolls where a neighboring low spot with deeper soils had much lower tree densities with only a few medium to small pine trees with some smaller fir trees interspersed. These two areas are variable, but the rocky soil is not necessarily the ideal location to retain higher basal areas. In contrast, the lower deeper soil location could support more basal area while still maintaining sustainable tree growth. Alternative 1 prescriptions aim to help remedy some of these types of situations.

Alternative 3 prescriptions, as discussed above, are not intended to increase variability and therefore any variability that occurred would most likely be by coincidence and might not occur in areas that would naturally have higher variability.

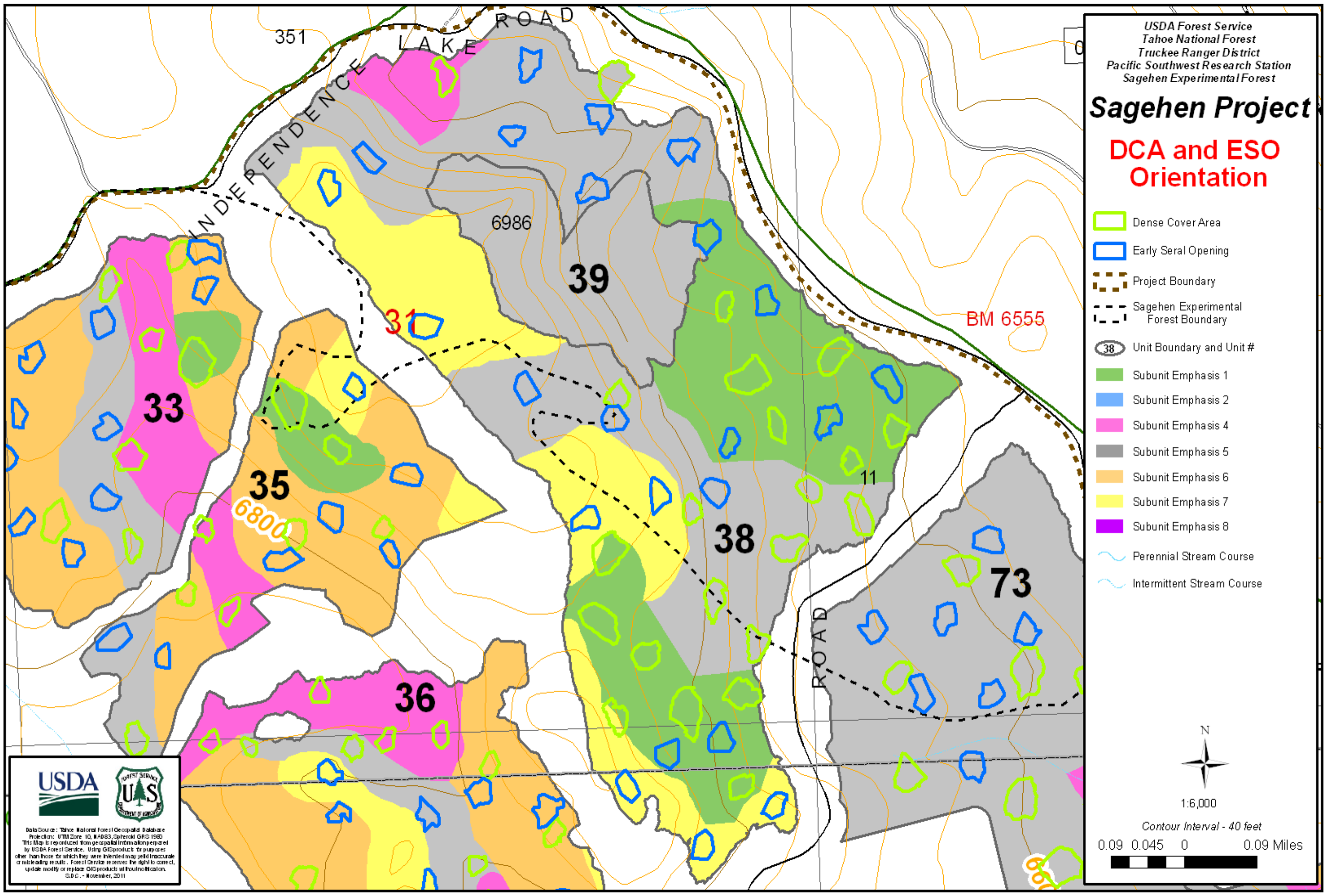
This project also intends to increase managed variability at the stand scale. Under Alternative 1, this variability, among other Project goals, would be achieved through the creation of early seral openings (ESOs) and dense cover areas (DCAs). The ESOs would create small, temporary situations of basal area and canopy cover metrics near zero while the DCAs would maintain much higher canopy cover percentages and basal areas that other prescriptions would not preserve. See Table 2 under the DCA/ESO treatment prescription to understand how many acres of these treatments were prescribed within each unit and their respective emphasis areas. Under Alternative 1, approximately 6 percent of the total area within units would be treated with the DCA or ESO prescription.

Without multiple low intensity disturbances, such as fire, affecting the landscape over time, much of the Project Area in its current condition has become relatively homogeneous and has few within-stand openings or ESO-like areas such as would have developed under active fire conditions. Without dense areas (e.g. DCAs) intermixed with less dense and open areas (e.g. ESOs), there would be minimal variability at the stand scale under Alternative 2. In the event of potential future disturbances, the area's current homogeneous condition would likely lead to effects that are uncharacteristic of what would have developed through a myriad of smaller and lower intensity disturbances over many years. Under the No Action Alternative, these disturbances would have a high probability of becoming stand replacing. Granted, stand replacing events do create variability, but at a much larger scale than what would have developed with active fire conditions under an active fire regime.

Alternative 3 prescriptions are not intended to enhance variability. In fact, any natural variability at the stand scale would most likely be moderated by the Alternative 3 prescriptions.

As with variability at the site scale, it is important to understand how variability at the stand scale is managed under each alternative. The variability effect of the treated 6 percent in DCAs and ESOs across the Project Area under Alternative 1 is maximized through tactical spatial arrangement. A snapshot of this arrangement over the northeast portion of the Project Area can be seen in Map 3.

Map 3: Alternative 1: A Sample DCA and ESO Orientation Snapshot



Notice the higher amounts of DCAs that occur in lower numbered emphasis areas and a higher amount of ESOs in higher numbered emphasis areas, mimicking what active fire might produce in these different topographical areas. Therefore, by applying these treatments strategically throughout the majority of the Project Area, variability is managed much more than if they were placed randomly.

Alternative 2 would result in minimal variability, and since that minimal variability would not be managed, it would be largely random. As previously discussed, the No Action Alternative would result in condition whereby disturbance events would have a high probability of becoming stand replacing. While stand replacing events do create variability, it would occur at a much larger scale than what would have naturally developed under active fire conditions.

Alternative 3 has only fuel reduction focused prescriptions, and any variability that was not moderated by the treatment prescriptions would be random and would not necessarily enhance variability.

Finally, it is important to have managed variability at the landscape scale. This can be measured within the landscape by correlating emphasis areas of the project area using canopy cover, basal area and mortality modeled by FVS and then calculating both the coefficient of variation and coefficient of determination through linear regression. Then, these indicators can be compared between alternatives.

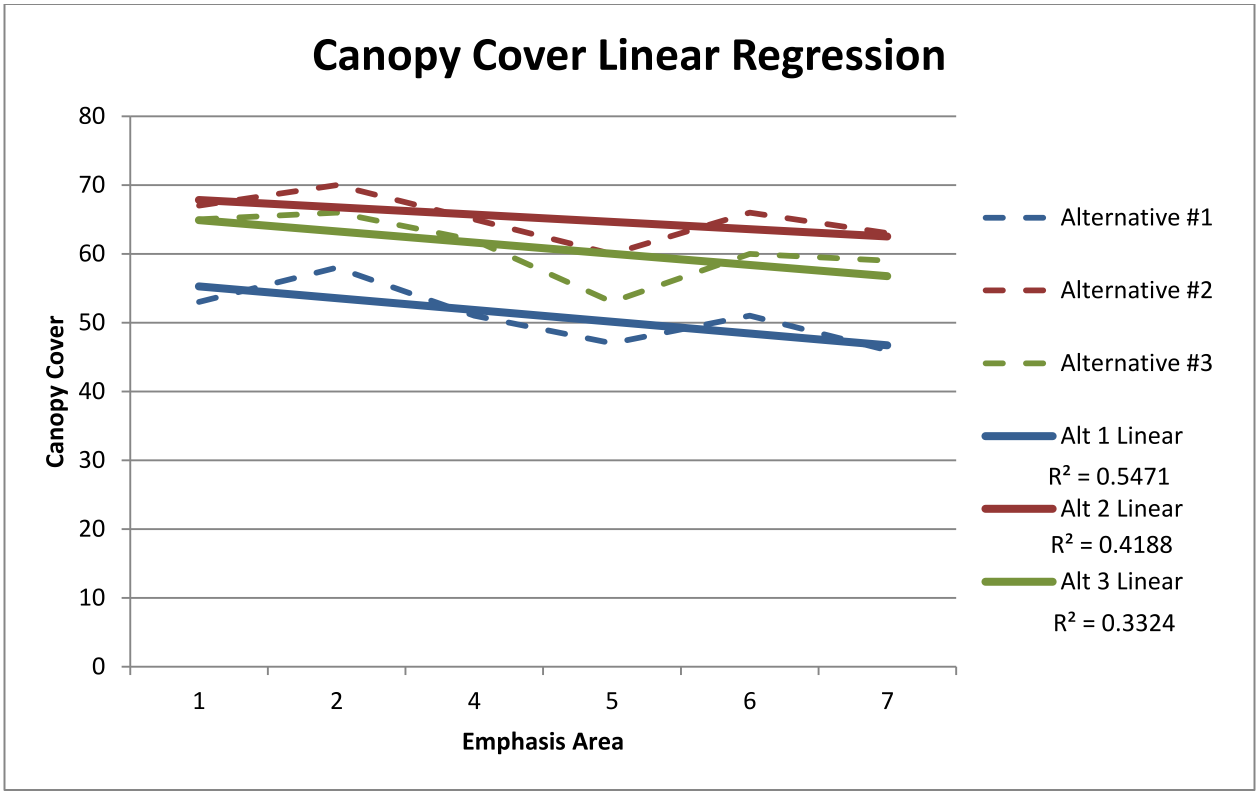
First, canopy cover between emphasis areas, post treatment, will be analyzed in order to assess managed variability at the landscape scale.

Table 28: Canopy Cover and Coefficient of Variation between Emphasis Areas for all Alternatives, Post Treatment

Emphasis Area (EA)	Total Emphasis Acres	Alternative1 Canopy Cover	Alternative 2 Canopy Cover	Alternative 3 Canopy Cover
EA 1 (weighted average)	453	53%	67%	65%
EA 2 (weighted average)	103	58%	70%	66%
EA 4 (weighted average)	173	51%	65%	62%
EA 5 (weighted average)	1028	47%	60%	53%
EA 6 (weighted average)	740	51%	66%	60%
EA 7 (weighted average)	150	46%	63%	59%
Canopy Cover Coefficient of Variation Between Emphasis Areas		**9%**	**5%**	**8%**

Table 28 shows a marginal variability improvement in canopy cover in Alternative 1 over Alternative 3, but as much as a 4 percent increase over Alternative 2.

Figure 1: Post Treatment Canopy Cover Linear Regression Analysis



Not only does Alternative 1 have the highest amount of variability among all the alternatives when looking at canopy cover, but it does so with the least volatility (differences in weighted average canopy cover percentages between adjacent emphasis areas) as shown with the highest R^2 value. Alternative 1's R^2 value is 0.1283 higher than Alternative 2 and 0.2147 higher than Alternative 3, which means Alternative 1 has a 31 percent decrease in volatility over Alternative 2 and a 65 percent decrease in volatility over Alternative 3.

Next, basal area will be analyzed between emphasis areas at the same point in time in order to assess managed variability at the landscape scale.

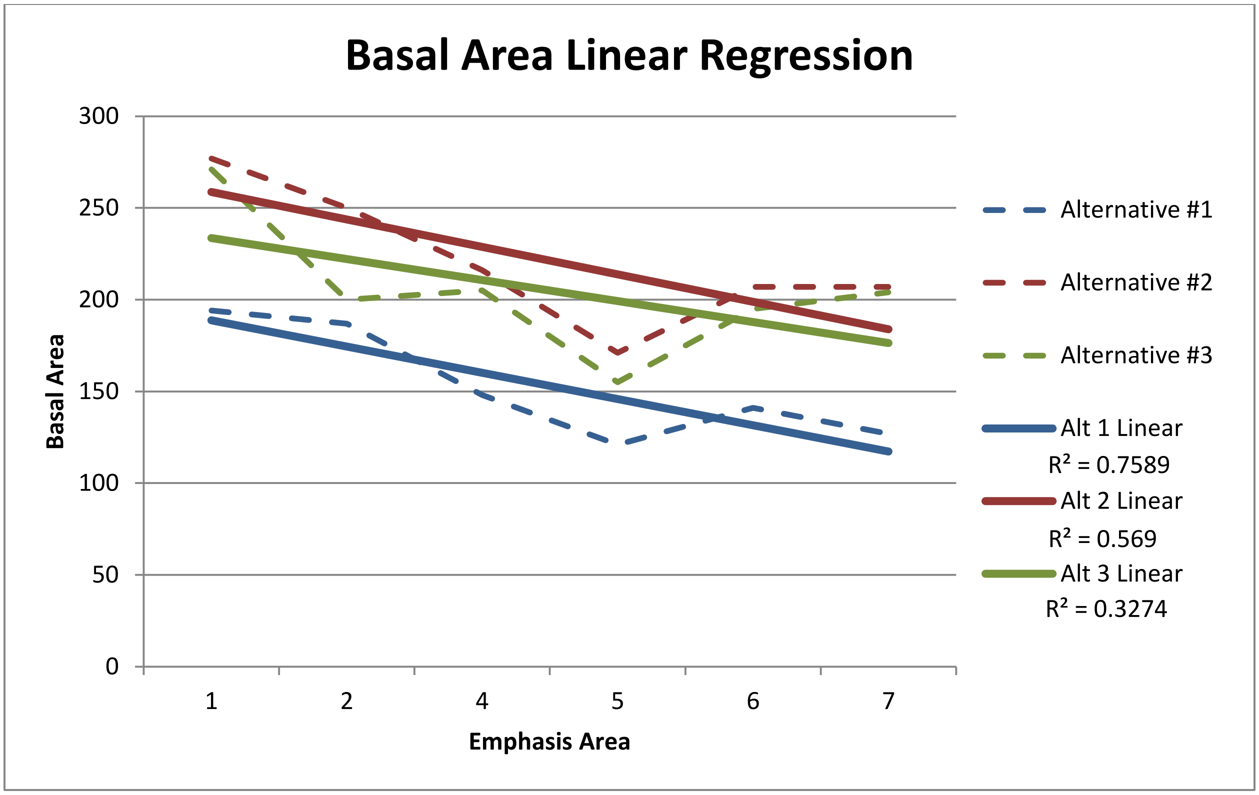
Table 29: Basal Area Coefficient of Variation between Emphasis Areas for all Alternatives, Post Treatment

Emphasis Area (EA)	Total Emphasis Acres	Alternative 1 Basal Area (sq. ft./ac.)	Alternative 2 Basal Area (sq. ft./ac.)	Alternative 3 Basal Area (sq. ft./ac.)
EA 1 (weighted average)	453	194	277	271
EA 2 (weighted	103	187	250	200

Emphasis Area (EA)	Total Emphasis Acres	Alternative 1 Basal Area (sq. ft./ac.)	Alternative 2 Basal Area (sq. ft./ac.)	Alternative 3 Basal Area (sq. ft./ac.)
average)				
EA 4 (weighted average)	173	148	216	205
EA 5 (weighted average)	1028	121	171	155
EA 6 (weighted average)	740	141	207	195
EA 7 (weighted average)	150	127	207	204
Basal Area Coefficient of Variation Between Emphasis Areas		**20%**	**17%**	**18%**

As with canopy cover, Alternative 1 shows the most variability in basal area between emphasis areas, as expressed by coefficient of variation, over the other alternatives. The following graph (Figure 2) displays the volatility of each alternative's basal area variability.

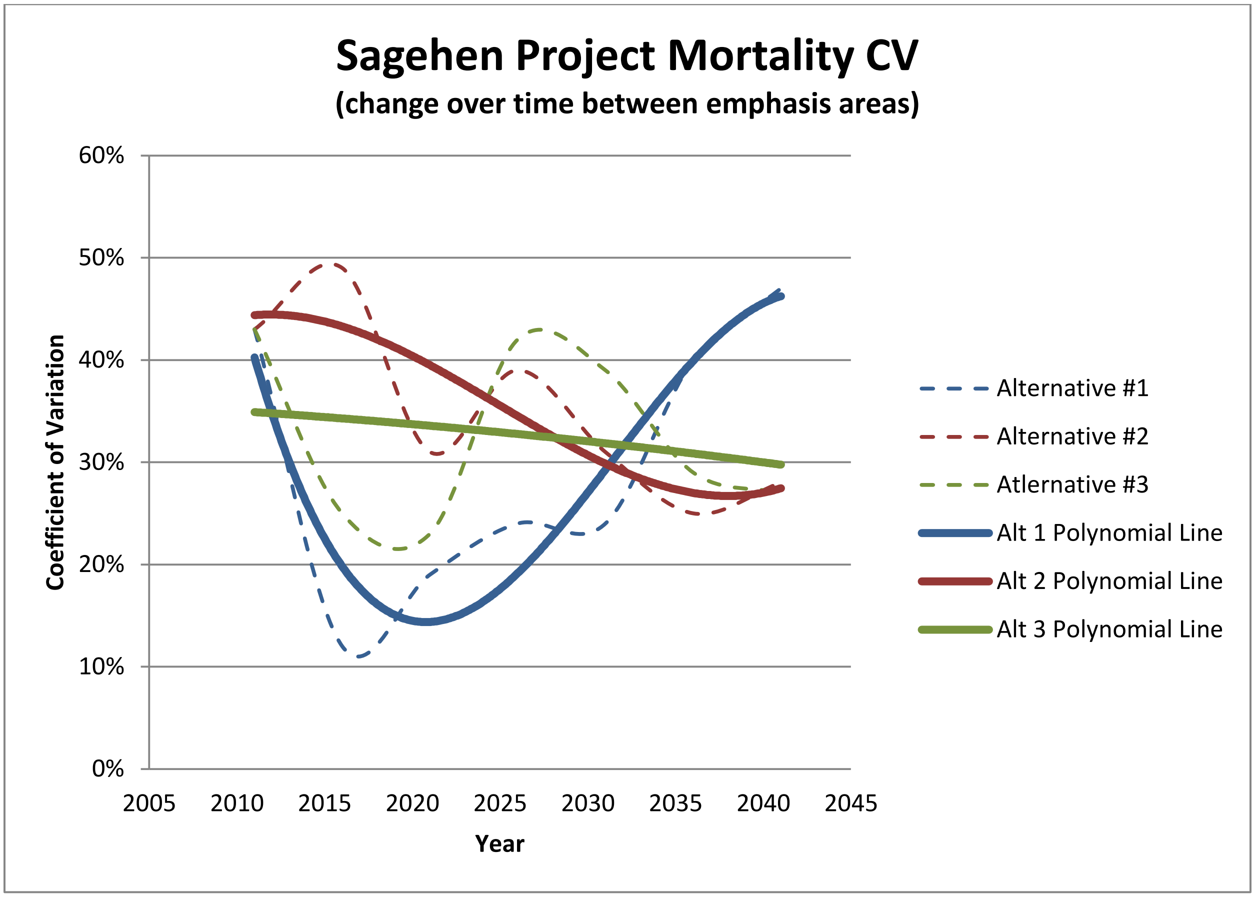
Figure 2: Post Treatment Basal Area Linear Regression Analysis



Alternative 1 has the most variability as well as the least amount of volatility (differences in weighted average basal area between adjacent emphasis areas) of all alternatives. Alternative 1's R^2 value is 0.1899 higher than Alternative 2 and 0.4315 higher than Alternative 3. In other words, as measured using basal area, Alternative 1 is 65 percent less volatile than Alternative 2 and 132 percent less volatile than Alternative 3.

Finally, it is important to look at how mortality varies at the landscape scale. Because mortality expresses the culminating effects of each silvicultural prescription, such as basal area reduction targets and species preferences, it is important to understand how mortality responds with respect to variability between emphasis areas across all alternatives over time as shown in Figure 3.

Figure 3: Change in Mortality Coefficient of Variation between Emphasis Areas Over Time



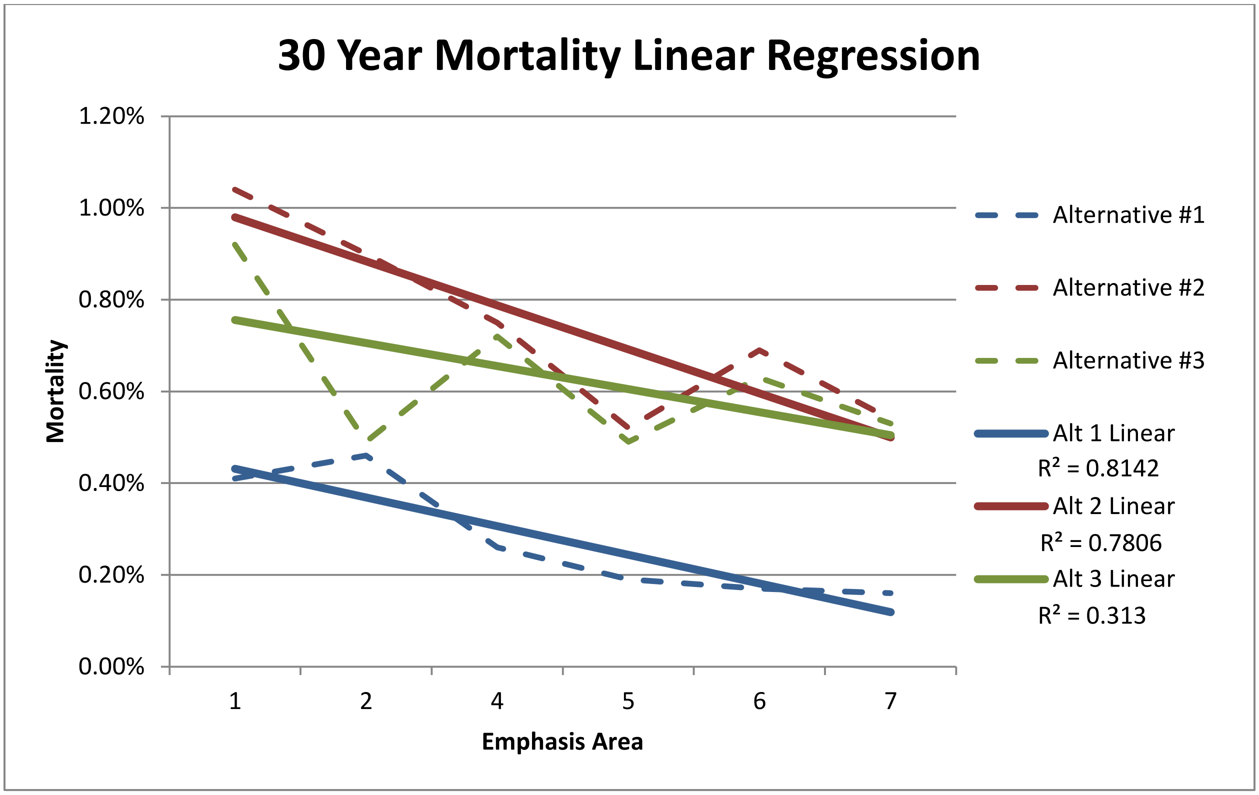
Although mortality variability between emphasis areas of Alternative 1 decreases after treatment due to the initial moderation of density related stresses within all the emphasis areas from those treatments, the unique prescriptions within each emphasis area begin to take on mortality at different amounts by 2017. The coefficient of variation is even predicted to increase by as much as 35 percent in 25 years and is projected to be 4 percent higher than the current condition by 2041.

Alternative 2 shows an initial “pop” in variation, but over time, that variation begins to moderate and continues on a downward trend of homogenizing mortality through the analysis period. In 30 years, that mortality variation between emphasis areas is almost 20 percent less than Alternative 1.

Alternative 3 fluctuates over time, but if analyzed as a trend, variability decreases over time and ultimately has similar amounts of variability as Alternative 2 in 2041, which is well below where Alternative 1 is projected to be at that same time.

This variability must also be understood in terms of volatility. Instead of trying to ascertain how volatile mortality is between emphasis areas over time, this analysis considers the volatility of that variability 30 years after treatment in Figure 4.

Figure 4: Mortality Linear Regression Analysis in 2041



In 30 years, Alternative 1's R^2 value is 0.0336 higher than Alternative 2 and 0.5012 higher than Alternative 3. Therefore, Alternative 1 reduces mortality volatility between emphasis areas by as much as 4 percent over where Alternative 2 is predicted to be at the same time and over 160 percent reduction in volatility over where Alternative 3 is predicted to be at the same time.

Ultimately, variability can occur at many scales and be completely random, but it is understood that Sierra Nevada forest systems with more active fire conditions under an active fire regime showed variability at all scales (site, stand, and landscape) and were logically adapted to topographical situations. Alternative 1 shows enhanced variability over both Alternatives 2 and 3 in every indicator at every scale analyzed. Not only does Alternative 1 increase variability in every indicator at every scale analyzed, but does so strategically in a way that mimics what would have occurred with active fire conditions under an active fire regime.

D. CUMULATIVE EFFECTS

The cumulative effects analysis area for forest stands generally encompasses the Sagehen Project Area. This 9,478-acre area includes both National Forest System and private lands, and was selected to capture landscape-level effects of management actions on forest stands. The cumulative effects analysis temporal scale extends 30 years before and after the present, corresponding with the estimated longevity of vegetation treatments.

Effects of Past Actions on Forest Stands

Past actions that could contribute to a cumulative effect on forest stands in the analysis area include larger vegetation treatments (greater than 10 acres), prescribed fire, and wildland fire exclusion.

Vegetation Treatments. The Sagehen Project Area has had various vegetation treatments over the last 30 years as shown below. (Treatments under ten acres were not included because their scope limits their ability to affect the surrounding landscape.)

- Golden Timber Sale – 1988; 368 acres
  Select Tree Cut and Seed Tree Cut that removed approximately 34 trees per acre between 12 – 35 inches dbh

- Sagehen Salvage Sale – 1990; Sale area boundary encompassed 2,433 acres however salvage harvesting operations were conducted on an estimated 800 acres
  Select Tree Cut that removed approximately 1-5 dead and dying trees per acre

- Sagehen Fuel Break – 1998; 107 acres
  Commercial Thin that removed approximately 200 trees per acre between 3 – 29.9 inches dbh

- Spring Chicken Fuel Break – 2002; 417 acres
  Commercial Thin that removed approximately 200 trees per acre between 3 – 29.9 inches dbh

- Private Land Timber Harvests – 1981-2005; 1,050 acres
  Select Tree Cut, Clearcut, Shelterwood that removed most trees above 14.9 inches dbh

Each treatment has left unique effects on the landscape and must be discussed individually to ascertain its additive result on the Project Area.

Although the Golden Timber Sale only involved 368 acres, it included the most intensive vegetation treatments in the last 30 years on National Forest System land within the Project Area. Much of these treatments can be seen today; particularly the select tree and seed tree cut units. All select tree cut units have little to no smaller trees (trees less than ten inches dbh) and a varying degree of overstory, larger trees. These units do provide a break in surrounding, high density forest, but offer little heterogeneity within the treatment itself. Further, the remaining trees have little decadence, but will have a good likelihood of remaining and thriving on the landscape. The seed tree cut units have an abundance of regeneration, but little overstory. This area provides the landscape with an early seral, developing forest, but does so in relatively small amounts and in uncharacteristically larger-sized swaths.

The Sagehen Salvage Sale was in response to white fir die off from a fir engraver beetle outbreak from the late 1980s. Although this Sale covered the largest area within the Project Area, it was the least intensive in terms of vegetation management and actually involved tree removal on approximately 800 acres. Only 1-5 trees per acre were removed, and the majority of the trees removed were in the southwestern portion of the Sagehen Basin. Only dead white fir trees with value were selected for removal. This removal, most likely, had little effect on the remaining tree health, but did ultimately affect forest structure across the Project Area by reducing the number of larger snags and subsequent larger down woody material that would have otherwise existed on the landscape.

Both fuel break thinning projects totaled approximately 500 acres, but were strategically placed along the 11 Road to reduce fire behavior for ingress of potential firefighting resources and egress of the public during a wildfire event inside the Sagehen Basin. Much like the select tree cut from the Golden Timber Sale, units have little to no smaller trees (trees less than ten inches dbh) and a varying degree of overstory, larger trees. These units do provide a break in the surrounding, high density forest, but offer little heterogeneity within the treatment itself. Further, the remaining trees have little decadence, but will have a good likelihood of remaining and thriving on the landscape. Finally, these units are very linear in nature, and although they function well as a fire behavior reducing buffer, they hold little resemblance to natural variability in terms of their position on the landscape.

The most intensive treatments within the Sagehen Basin occurred on private land in the southeastern portion of the Project Area. The varied amounts of treatments on private land, however, provide for the most dramatic variability. However, each treatment is still quite homogenous in character and does not provide for variability at scales that would have occurred with active fire conditions. Further, treatments were skewed towards taking many of the largest and most resilient trees on the landscape. So, although there may be healthy and vigorous regeneration on much of the private land, it is generally not in a configuration that would have occurred under active fire conditions and is not complimented by adjacent older forest stands.

Overall, assorted goals drove a variety of treatments within the Sagehen Project Area since the early 1980s. This drives some of the variability that exists on the landscape today, but the common factor for all of these treatments is the amount of variability that is lacking within treatment units or at the site scale. Further, these treatments may have the ability to slow certain disturbances, but are most likely not large enough nor strategically placed to significantly interrupt their progression.

Prescribed Fire. Prescribed fire treatments are grouped by two types: pile burning and underburning. Approximately 766 acres of prescribed fire treatments occurred within the cumulative effects analysis area during the past 30 years. An estimated 452 acres were pile burned and 314 acres underburned. Underburning generally consumes surface fuels dispersed throughout a treatment area whereas pile burning consumes aggregated materials. The overall effect of prescribed fire treatments has been to reduce fuel loading within the treated stands, thereby increasing the chances that, in the event of a wildland fire, extensive tree mortality (particularly in trees greater than 12 to 14 inches dbh) would be minimized. Prescribed fire has had an overall beneficial effect on forest stands within the analysis area, but has not been applied across enough of the Project Area to positively affect the larger landscape.

Fire Exclusion. Forest ecosystems derive beneficial effects from periodic wildland fire, yet this important element of the ecosystem has been excluded in the analysis area for at least the past 100 years in most areas (missing one or more fire return intervals) and 60 years in remaining areas (Donner Ridge Fire). Natural stands in the analysis area and the extensive Donner Ridge and Independence Fires' plantation stands are comprised of tree species and vegetation communities adapted to wildland fire. As a result of fire exclusion, the spatial distribution, composition, and density of vegetation communities have been altered. Shade tolerant species, such as white fir, have benefited, increasing in distribution and composition within stands and at the landscape level, and increasing in density (e.g. greater basal area and number of stems per acre) at the stand level. Conversely, shade intolerant species, such as ponderosa pine and sugar pine, have been detrimentally affected. Effects of fire exclusion over the past 30 years on forest stands cannot be quantified because they depend upon a complex, dynamic interaction of factors that determine fire extent and severity, including fire weather, fuel moisture, aspect, slope, and existing vegetation structure (vertical and horizontal), composition, and density. However, effects of fire exclusion have shaped the existing dense stand conditions prevalent within the analysis area today. Past vegetation treatments may have accomplished some forest health and resiliency benefits; however, these beneficial effects have not entirely compensated for the beneficial effects that would have occurred under more active fire conditions in the analysis area.

Effects of Present Actions on Forest Stands

The Sagehen Project Area has only one ongoing vegetation management project, Billymass. This project is under contract, but is not yet complete. This project covers 1,260 acres, 494 of which are within the Sagehen Project Area. All 494 acres are plantations from the Donner Ridge Fire and have spacing guideline prescriptions similar to those prescribed for units 46 and 47 in this project. The effect of this present action would not only free up available resources for the remaining trees within the Billymass Project units, but are large enough to affect how a disturbance, particularly fire, might move through the Project Area. Unlike Sagehen Project plantation prescriptions, however, there is little variability prescribed for these units at the site, stand, or landscape scale.

Effects of Reasonably Foreseeable Future Actions on Forest Stands

There are no known reasonably foreseeable future vegetation management projects within the analysis area. Although wildland fire exclusion is expected to continue with effects as described above for past actions, the desire for some level of prescribed and wildfire at intervals consistent with natural fire regimes to be returned to the Sagehen Basin is recognized. However, because the uncertainty of budgets and time for future analysis and implementation, evaluating effects of additional prescribed fire that has not been planned for is outside the scope of this analysis.

Summary of Effects of Past, Present, and Future Actions on Forest Stands

Overall, assorted goals drove a variety of treatments within the Sagehen Project Area since the early 1980s. This drives some of the variability that exists on the landscape today, but the common factor for all of these treatments is the amount of variability that is lacking within treatment units and at the site scale. These past treatments may have the ability to slow certain disturbances; however, all but the Billymass units are most likely not large enough or strategically placed to significantly interrupt their progression. The Billymass units are large enough to interrupt larger disturbances, but could only do so from the southeastern portion of the Project Area.

Cumulative Effects under Alternative 1

Under the Proposed Action Alternative (Alternative 1), forest stands would improve in structure and resilience with a positive net effect over the entire Sagehen Project Area. This is generally due to the decrease in competition among all remaining trees in both past and proposed action units as well as the presence of some larger scale variability in past action units and the multi-scaled variability resulting from proposed action treatments. Further, where treatment units overlap with some of the homogenous treatments of the past, prescriptions aim to not only take advantage of the positive attributes of past treatments (such as reducing competition around larger trees), but are designed also find opportunities to introduce more heterogeneity within them. Past treatment areas that do not overlap with Alternative 1 treatments would most likely continue to develop aided by the increased resiliency from surrounding treatments, but with minimal smaller scale and strategically introduced variability. Ultimately, the cumulative effects of the past and present treatments combined with Alternative 1 treatments would benefit individual tree growth and resiliency within all units (historical, present or proposed), and by having reduced competition within all units, larger scale disturbances that could occur within the Sagehen Project Area would most likely be interrupted. Therefore, Alternative 1 would result in a positive cumulative effect on forest stands in the analysis area over the 30-year cumulative effects analysis temporal scale.

Cumulative Effects under Alternative 2

Under the “No Action” Alternative (Alternative 2), current declining forest health trends would continue in the Sagehen Project Area, particularly outside of past treatment unit boundaries. Stand densities would continue to increase and forest fuels would continue to accumulate. In the absence of disturbance, such as wildfire, shade intolerant tree numbers would decline due to lack of sunlight. Structural diversity would slowly improve as large trees died and created gaps for regeneration. Because of the limited amount of light reaching the forest floor, most regeneration would be shade tolerant species, such as white fir. White fir is less able to tolerate drought or fire than the less shade tolerant pines. Implementation of Alternative 2 would result in adverse indirect impacts on forest health, specifically stand density and tree species composition. Past treatment areas would most likely continue to develop, but would be at a higher mortality risk from disturbances from surrounding untreated stands. Therefore, Alternative 2 would result in a negative cumulative effect on forest stands in the analysis area over the 30-year cumulative effects analysis temporal scale.

Cumulative Effects under Alternative 3

Under the “Non Commercial Funding” Alternative (Alternative 3), current declining forest health trends would continue in the Sagehen Project Area, particularly outside of past treatment unit boundaries and outside Alternative 3 unit boundaries. Conditions within past unit boundaries and Alternative 3 unit boundaries (to a slight extent since this alternative is focused on hazardous fuels reduction and is not designed to address forest health needs) would be on a more resilient trajectory, but are not large enough to complement each other or provide sufficient benefit to the larger landscape. Therefore, Alternative 3 would result in a negative cumulative effect, albeit slightly less than Alternative 2, on forest stands in the analysis area over the 30-year cumulative effect analysis temporal scale.

E. SUMMARY COMPARISON OF ALTERNATIVES

Table 30 summarizes effects on stand density, medium and large trees, mortality, and canopy cover by alternative for comparison to one another as well as to scientifically established recommendations for a Sierra Nevada forest ecosystem with active fire conditions under an active fire regime. For a full explanation of these effects see direct and indirect effects of this report (IV – C)

Table 30: Summary of Effects on Stand Density, Medium and Large Trees, Mortality and Canopy Cover by Alternative

	30 Year Weighted Basal Area Average (sq. ft./ac.)	30 Year Weighted Average % of Basal Area in Medium and Large Trees	Remaining Numbers of Medium and Large Trees Per Acre Post Treatment (outside of Plantations and Natural Young Forest)	30 Year Weighted Average Mortality %	30 Year Weighted Average % Mortality in Trees greater than 14.9 inches dbh	Post Treatment Canopy Cover
Alternative. 1	202	49%	25-33	0.24%	49%	48%
Alternative. 2	259	40%	28-36	0.80%	25%	63%
Alternative. 3	244	44%	28-36	0.61%	36%	58%
Characteristics of Sierra Nevada Forests with Active Fire Conditions Under an Active Fire Regime	Basal Area that can support sustainable growth and mortality	Majority of Basal Area in Medium and Large Trees (North et al., 2009)	18-36 (Taylor 2004)	.0162% (Stephens and Gill 2005)	Majority of Mortality in Trees greater than 14.9 inches dbh	Canopy Cover greater than 40 percent in most stands (Forest Plan 2004)

Table 31 summarizes managed variability by alternative for comparison to one another as well as to scientifically established recommendations for a Sierra Nevada forest ecosystem with active fire conditions under an active fire regime.

Table 31: Summary of managed variability by Alternative

	Site Scale Canopy Cover CV	Site Scale Basal Area CV	Stand Scale % Affected	Landscape Scale Canopy Cover CV	Landscape Scale Canopy Cover R^2	Landscape Scale Basal Area CV	Landscape Scale Basal Area R^2	Landscape Scale 30 Year Mortality CV	Landscape Scale 30 Year Mortality R^2
Alternative 1	26%	49%	6%	9%	.55	20%	.76	47%	.81
Alternative 2	18%	31%	n/a	5%	.42	17%	.57	28%	.78
Alternative 3	n/a	n/a	n/a	8%	.33	18%	.33	27%	.31
Characteristics of Sierra Nevada Forests with Active Fire Conditions Under an Active Fire Regime	Higher CV (North 2012)	Higher CV (North 2012)	Higher CV (North 2012)	Higher CV (North 2012)	R^2 Closer to 1.0	Higher CV (North 2012)	R^2 Closer to 1.0	Higher CV (North 2012)	R^2 Closer to 1.0

* CV = Coefficient of Variation; R^2 = Coefficient of Determination

Basal area targets were primarily driven by other project goals, but density reduction did help inform those targets. However, it is challenging to assess the effectiveness of reducing density related stresses if basal area is examined as an isolated indicator. Although Alternative 1 would reduce basal area more than the other alternatives, this conclusion must be assessed in terms of basal area distribution across tree size classes to fully ascertain stand density and resiliency. The analysis shows that, after 30 years, Alternative 1 would produce more basal area in trees greater than 19.9 inches dbh than Alternative 2 (no action) or Alternative 3. This means that Alternative 1 would create conditions with the least amount of trees, yet Alternative 1 densities would remain within Forest Plan requirements while still meeting other project goals. This translates to the least amount of density related stresses to Project Area stands under Alternative 1, while Alternative 2 would generate the densest conditions.

The percentage of basal area comprised of trees greater than 19.9 inches dbh can also help evaluate size class distributions, while scientific literature can help inform what distributions would most likely have occurred in a more active fire regime with active fire conditions. Current conditions, if broken down into diameter size classes, show a reverse-j diameter distribution curve. In other words, the majority of the basal area is in trees less than 20 inches dbh. Research indicates that forests with active fire conditions had more of the basal area in medium- and large-sized trees (trees greater than 19.9 inches). If the units that are in early seral stages (plantations and natural young forests) are removed from this analysis, approximately two-thirds of the basal area is composed of trees greater than 19.9 inches under Alternative 1, well within ranges set forth by literature for a fire dependent forest system (North et al., 2009).

Since some project goals require the removal of some trees between 20 inches dbh and 29.9 inches dbh, it is important to understand whether the remaining populations of those medium and large trees from alternative prescriptions is analogous to populations that existed under active fire conditions. The literature (Taylor 2004) explains that in a similar ecosystem, about 18-36 medium and large trees per acre existed on the landscape with active fire conditions under an active fire regime. All alternatives keep medium and large tree populations well within that range (Table 30).

As disclosed earlier, basal area reductions combined with the movement of that basal area into different size classes produces a range of forest stand densities among the alternatives. These densities equate to certain mortality amounts in an array of tree size classes. Further, the literature describes what an appropriate amount of mortality might be and where that mortality might occur in a forest system with active fire under an active fire regime (Stephens and Gill 2005). Alternative 1 would generate the least amount of mortality of all the alternatives after 30 years. While Alternative 1 mortality amounts are not quite in line with levels the literature suggests for a fire adapted system, this alternative allows Project Area forests to potentially acquire the most trees with old growth characteristics compared to Alternatives 2 and 3 (Stephens and Gill 2005). Alternative 3 and particularly Alternative 2 produce mortality amounts much greater than what the science suggests would occur within a fire adapted ecosystem (Stephens and Gill 2005). Alternative 2 and Alternative 3 would produce forest stands that could acquire unsustainable amounts of mortality after 30 years and would have difficulty acquiring trees with old growth characteristics. Under Alternatives 2 and 3 most of the tree mortality would occur in predominantly smaller trees (less than 15 inches dbh), while most of the trees dying under Alternative 1 stands would be greater than 14.9 inches dbh. As shown by these mortality metrics, Alternative 1 would not only help meet other project goals, such as enhancing the snag population of trees greater than 14.9 inches dbh and reducing the amount of fine fuels, but implementation of the silvicultural prescriptions proposed under Alternative 1 would produce conditions where more trees perish from something other than density related stresses. Alternatives 2 and 3 could actually encumber other project goals, for example, by increasing the fine fuel loading, and would produce a forest system where trees were more likely to die from density related stresses at younger ages and smaller sizes.

Canopy cover would be reduced the most under Alternative 1, but canopy cover levels would still meet Forest Plan standards and guidelines. This reduction in canopy cover would aid shade intolerant species regeneration and improve growing conditions for the remaining trees. Alternative 2 would not reduce canopy cover. A closing canopy would hinder shade intolerant species regeneration, minimize available growing sites, and create advantageous conditions for shade tolerant species to become dominant. Alternative 3 would reduce canopy cover in some of the units while still meeting Forest Plan standards and guidelines. Alternative 3 would improve growing conditions for some trees and create some opportunities for shade intolerant species regeneration, but not nearly to the level under Alternative 1.

Project Area units have limited amounts of variability in their current condition at scales important to ecosystem processes of a forest affected by active fire conditions. Further, the variability that does exist is often random and may not be distributed in a manner consistent with what active fire conditions might create. Alternative 1 would increase variability at the site, stand, and landscape scale to a higher degree than the other alternatives. In addition, Alternative 1's silvicultural prescriptions would increase variability through careful management that would mimic the variability that would most likely exist within a forest affected by active fire conditions. Table 31 above summarizes these metrics at all scales.

First, Alternative 1 prescriptions would produce the most variability at the site scale. Coefficient of variation calculations of canopy cover and basal area based on results of the test plot treatments show, on average, an increase in variability of approximately 13 percent at the site scale over the current condition (which provides an indication of the effect of the No Action Alternative (Alternative 2)).

Alternative 3 would most likely decrease variability at the site scale. Alternative 1 “Prescription and Treatment Method Definitions” section explains how the prescribed variability would be accomplished in a strategic way.

Alternative 1 is also the only alternative to show a measurable increase in managed variability at the stand scale (where the current condition has limited amounts of variability). Approximately 6 percent of the Project Area would be treated using the Dense Cover Area (DCA) and Early Seral Opening (ESO) prescription under Alternative 1. Alternatives 2 and 3 have no such prescriptions proposed. DCAs increase variability at the stand scale by preserving areas with sustainable density and structure, while ESOs increase variability at the stand scale by creating opportunities for earlier seral forests to become established. Both treatments are prescribed in patch sizes consistent with what active fire conditions might produce. Further, DCA and ESO treatments are placed strategically within stands according to where they would reside topographically under a more active fire regime with active fire conditions.

Finally, Alternative 1 prescriptions produce the most variability in a managed way at the landscape scale compared to Alternatives 2 and 3. Alternative 1 prescriptions result in, on average, a 9 percent increase in variability over Alternative 2 and an 8 percent increase over Alternative 3 when measured by canopy cover, basal area, and mortality. Alternative 1 prescriptions would also create this variability in managed ways consistent with the conditions of forested landscapes under active fire conditions. As discussed in the “Emphasis Area Creation” section under Alternative 1, landscape boundaries were derived from topographical analysis. This helped inform stand conditions that would have been present within those boundaries under more active fire conditions. The emphasis areas were then lineally organized, moving from emphasis area 1 to emphasis area 7, by a gradual decrease in how much basal area an emphasis area would support if influenced by active fire. Considering that changes in basal area directly affect selected stand metrics (canopy cover and mortality), changes between emphasis areas for these metrics should follow similar patterns as those for the basal area metric. Therefore, the more dramatic changes in measured values (basal area, canopy cover and mortality) between numerically adjacent emphasis areas (for example, but not limited to, between emphasis area 1 as compared to 2, emphasis area 2 as compared to 4, or emphasis area 6 as compared to 7), means fewer resemblances to what might have occurred if Project Area units had been affected by active fire. To assess the potential for dramatic shifts in forest stand conditions, linear regressions for selected forest stand metrics (including immediate post-treatment basal area and canopy cover and 30-year projected mortality) by emphasis area under each alternative were compared using the coefficient of determination, referred to as R^2. In regression, the R^2 (coefficient of determination) is a statistical measure of how well the regression line approximates the real data points. An R^2 of 1.0 indicates that the regression line perfectly fits the data. Therefore, the greater the values of the metrics (such as basal area, canopy cover, and mortality) deviate from the values predicted (modeled) under active fire conditions, the more volatile (further away from an R^2 value of 1.0) they are considered. It is desirable to have less volatility, which means that the data presented are closer to the modeled values, thus a better fit and more closely representing the desired condition of values under active fire conditions. Under each metric, Alternative 1 produced the R^2 value closest to 1.0. Therefore, compared to Alternatives 2 and 3, Alternative 1 most closely mimics the variability expected under an active fire regime with active fire conditions and most closely approximates where this variability would be situated on the landscape.

As discussed in "Direct and Indirect Effects" and this summary comparison, post-treatment conditions under Alternative 1 would more closely align with scientifically derived ranges for expected stand conditions (defined under "Indicators Used to Analyze Impacts on Forest Stands") in a Sierra Nevada forest with active fire conditions under an active fire regime than Alternatives 2 and 3 . In addition, Alternative 1 would maintain conditions within those ranges for the next 30 years after treatment. Further, the prescriptions of Alternative 1 would introduce the most managed variability at scales relative to important ecosystem processes and tend to put those particular areas of Project Area forests on a trajectory that is much more in line with what active fire conditions would produce compared to Alternative 2 or Alternative 3.

V. NFMA FINDINGS

All treatments proposed under the Sagehen Project have been designed to be consistent with Forest Plan direction, as amended, by the 2004 SNFPA ROD standards and guidelines for mechanical thinning treatments in mature forest habitat (CWHR types 4M, 4D, 5M, 5D, and 6), including the following:

- All live conifers greater than 30 inches dbh will be retained except where removal is necessary for equipment operability.
- Retain 40% of existing basal area (BA) generally comprised of the largest trees.
- Where available, design projects to retain 5 percent or more of the total treatment area in lower layers composed of trees 6 to 24 inches dbh within the treatment unit.
- Design projects to avoid reducing pre-existing canopy cover by more than 30% within the treatment unit.
- Within California spotted owl Home Range Core Areas, retain at least 50% canopy cover averaged over the treatment unit. Treatment Units 213, 156, and 163 are within a California spotted owl Home Range Core Area, and would be thinned to a density that maintains 50% canopy cover on average across the treatment areas.
- Outside of the California spotted owl Home Range Core Areas, and where needed to adequately reduce ladder fuels, provide for safe and efficient equipment operations, minimize re-entry, design cost efficient treatments, and/or significantly reduce stand density, canopy can be reduced to 40% cover on average within the treatment unit. The remaining treatment units are located outside of Home Range Core Areas. Canopy cover will not be reduced below 40% on average across the treatment areas in order to minimize re-entry, provide for cost efficient treatments, to reduce stand density, and to meet project goals.

The minimum specific management requirements to be met in carrying out projects and activities for the National Forest System (NFS) are set forth in this section. Under 16 U.S.C. 1604 (g)(3)(E), a Responsible Official may authorize project and activity decisions on NFS lands to harvest timber only where:

1. Soil, slope, or other watershed conditions will not be irreversibly damaged;
Implementation of the proposed action would adhere to Best Management Practices for Protecting Water Quality (BMPs) and Forest Plan standards and guidelines (including Riparian Conservation Area, RCA, guidelines) for protecting soil and water resources. Best Management Practices and Riparian Conservation Area Guidelines for the Sagehen Project are included the Sagehen Project Record.

2. There is assurance that such lands can be adequately restocked within five years after harvest;
The areas treated in the Sagehen Project would remain adequately stocked following thinning and follow-up fuels treatments. Subsequent stocking surveys would be performed within the project area the first and third year after implementation. If any areas larger than a quarter of an acre were considered insufficiently stocked as outlined by the Forest Plan by the third year stocking survey, reforestation efforts would commence.

3. Protection is provided for streams, stream banks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat; and
Management requirements incorporated into the proposed action are designed to reduce the risk of accelerated erosion and sedimentation due to silviculture and fuels treatment activities. The proposed action's Best Management Practices for Protecting Water Quality (BMPs) and the Forest Plan standards and guidelines (including RCA guidelines) for protecting soil and water resources are the primary measures for preventing and mitigating impacts from nonpoint source water pollution, such as fine sediment and changes in water temperature. Consistent with Forest Plan direction, a riparian conservation objective (RCO) analysis has been completed for the proposed action (available in the project record), which demonstrates that proposed activities would not seriously or adversely affect water quality or riparian/aquatic conditions.

4. The harvesting system to be used is not selected primarily because it will give the greatest dollar return or the greatest unit output of timber.
Treatment method selection was based on resource protection rather than economics. Steeper slopes (those generally over 25 percent) are not proposed for mechanical harvest, but for hand work only.

A Responsible Official may authorize project and activity decisions on NFS lands using clearcutting, seed tree cutting, shelterwood cutting, and other cuts designed to regenerate an even-aged stand of timber as a cutting method. None of the treatments proposed for the Sagehen Project are designed to regenerate even-aged stands of timber.

LITERATURE CITED

Agee, J.K. 1993. Fire ecology of Pacific Northwest Forests. Island Press, Wash. DC.

Ansley, J.S., and Battles, J.J., 1998. Forest composition, structure, and change in an old growth mixed conifer forest in the northern Sierra Nevada. J. Torrey Soc, volume 125, number 4. P 300

Brown, J.K. 1995. Fire regimes and their relevance to ecosystem management. Pages 171-178 *In* Proceedings of Society of American Foresters National Convention, Sept. 18-22, 1994, Anchorage, AK. Society of American Foresters, Wash. DC.

Dixon, Gary E., comp. 2003. *Essential FVS: A User's Guide to the Forest Vegetation Simulator.* Internal Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Forest Management Service Center. 193 p.

Fiala, A., Garman, S., Gray, A. 2006. Comparison of Five Canopy Cover Estimation Techniques in the Western Oregon Cascades. Forest Ecology Management 232. pp 188-197.

Knowles, Constance. 1942. Lumbering history of the Truckee Basin: 1856-1936. Division of Forest Survey, California Forest and Range Experiment Station, Berkeley, CA.

McKelvey, K.S.; Johnston, J.D. 1992. The California Spotted Owl: A Technical Assessment of its Current Status. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station; Gen. Tech. Rep. PSW-GTR-133

Myrick, David F. 1992. Railroads of Nevada and eastern California. volume I: the northern railroads. University of Nevada Press, Reno, NV.

North, Malcolm, ed. 2012**.** Managing Sierra Nevada forests. Gen. Tech. Rep. PSW-GTR-237. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 184 p.

North, M., P. Stine, K. O'Hara, W. Zielinski, and S. Stephens. 2009. An Ecosystem Management Strategy for Sierran Mixed-Conifer Forests. PSW-GTR-220.

Stephens, S., and Gill, S. 2005. Forest structure and mortality in an old-growth Jeffrey pine-mixed conifer forest in north-western Mexico. Forest Ecology and Management 205. p 24.

Taylor, A.H. 2004. Identifying Forest Reference Conditions on Early Cut-Over Lands, Lake Tahoe Basin, USA. Ecological Applications 14(6). pp 1903-1920.

Underwood, E., Viers, J., Quinn, J. and North, M. 2010. Using Topography to Meet Wildlife and Fuels Treatment Objectives in Fire-Suppressed Landscapes. Environmental Management, volume 46, number 5.

Valiant, Nicole, UC Berkeley 2008: Sagehen Experimental Forest Past, Present, and Future: An Evaluation of the Fireshed Assessment Process

Wilson, Dick. 1992. Sawdust trails in the Truckee Basin: a history of lumbering operations. Nevada County Historical Society, Nevada City, CA.